CONFERENCE REPORT No. 62

THE SOUTHERN REGIONAL
ASSOCIATION FOR THE BLIND
32 Old Queen Street, London SW1H 9HP

THE LEONARD CONFERENCE ON RESEARCH INTO VISUAL HANDICAP

GIRTON COLLEGE
CAMBRIDGE UNIVERSITY

d—5th January, 1972

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Chairman, Southern Regional Association for the Blind.

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Mr. J. A. WALL, M.A. (Oxon.)

Dr. HENRY HEATH, D.Sc., Ph.D., F.R.I.C.

Dr. DAVID A. ROBINSON, B.A., Ph.D.,
Research Sociologist, Institute of Psychiatry.

THE SOUTHERN REGIONAL ASSOCIATION FOR THE BLIND

LIST OF SPEAKERS

THE LEONARD CONFERENCE ON RESEARCH INTO VISUAL HANDICAP.

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Director of Research, St. Dunstan's.

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City of Birmingham College of Education.

Mr. M. Yelland, B.A., A.L.A.,
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M.R.C. Developmental Psychology Unit.

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London School of Economics and Political Science.

Miss Margaret Voysey, B.Sc. (Econ.),
Bedford College, University of London.

Dr. Anne Hayman, M.B., B.Ch., D.P.M.,
Research Psychoanalyst, The Hampstead Child Therapy Clinic.

Mr. C. Williams, M.Sc., A.B.Ps.S.,
Research Psychologist, Lea Hospital, Bromsgrove.

Dr. A. D. Heyes, B.Sc., Ph.D.,
Blind Mobility Research Unit, University of Nottingham.

The Leonard Conference was so named in memory of Dr. J. Alfred Leonard, B.A., Ph.D., Reader in the Department of Psychology at the University of Nottingham, who died after a few day's illness on 9th December, 1971. It was at his request that the Southern Regional Association for the Blind was bringing together as many people as possible engaged in University-based and other research into visual handicap. The energy, influence and sheer hard work of Dr. Leonard can account for much fresh research into visual handicap being promoted in various Universities during the past few years and it is tragic that he should die at an early age and before his work could be completed.

This Conference at Cambridge in January 1972 was the fourth with which Dr. Leonard had worked with the Association, the first being in London in July 1964, the second in Leicester in 1966 and the third in London in 1968. S.R.A.B. Conference Reports Numbers 53, 56 and 57 refer.

OPENING REMARKS BY THE CHAIRMAN

Mr. John A. Wall: Ladies and gentlemen, may I first welcome all of you to the first session of this Leonard Conference on research into visual handicap. Those of you who have looked at the programme will have noted that the first item on the agenda is by way of an obituary notice to Dr. Leonard by Professor Beurle. I will say nothing more about that myself, except that Alfred Leonard had been a very good friend to the Southern Regional Association for the Blind. He did a tremendous amount of work for us.

Shakespeare made Mark Anthony say:

> " The evil that men do lives after them,
> The good is oft interred with their bones.".

It is hoped that the good which Alfred Leonard did will live after him. Certainly this Conference is one of the good things he did and I sincerely hope that good will come of it. I suppose that one could copy the epitaph of Sir Christopher Wren:

> " If you seek his monument, look around."
> (" *Si monumentum requiris, circumspice.*")

Let this Conference be a memorial to our friend, Alfred.

It has always been the practice of the Southern Regional Association for the Blind to encourage co-ordination of activities for blind people among people in the local authorities in the area and other bodies, including the universities, and those concerned with research. The most important thing about this Conference in my view is that it will enable many of us, some coming from quite disparate disciplines, to meet each other in this hall and elsewhere in the College and talk about what is going on.

In the past few years there has been increasing emphasis on the need for university-based and other research into the problems of blindness and those of you who will be presenting papers during the sessions of this Conference will, I hope, be able to give all of us some indication of the work which you are doing.

We have one or two apologies for absence. Perhaps the most important is from Mr. Arthur Wilson of the Department of Employment and Productivity who, unfortunately, cannot be here because of other commitments. Some of you will be aware that his Department, in conjunction with the R.N.I.B. has been commissioning work by the Production Engineering Research Association, work that has been touched on in various R.N.I.B. publications from time to time. This is research which will be of considerable interest to those concerned with industrial work for blind individuals. Put in a general way, this involves the adaptation of machinery so that blind people can operate it in factories.

I always feel that, when a Chairman is called upon to open a conference of this kind, it is difficult not to steal anyone's thunder. So now I declare the Conference open. I ask Professor Beurle to pay a tribute to the late Dr. Alfred Leonard.

TRIBUTE TO DR. J. A. LEONARD

by Professor R. L. Beurle, B.Sc., Ph.D., M.I.E.E., F.Inst.P.,
Department of Electrical and Electronic Engineering,
University of Nottingham.

I have personally only known Alfred Leonard well since he came to Nottingham, so I would like to draw largely on the comments of others who have been associated closely with him. I shall quote very largely from Dr. D. E. Broadbent, Head of the Applied Psychology Unit of the Medical Research Council, under whom he worked in Cambridge, and Professor C. I. Howarth, Head of the Department of Psychology, in which he set up the Blind Mobility Research Unit in Nottingham.

Alfred came to this country from Germany in 1938, and, to quote Professor Howarth, " like so many of the refugees of that time, he has enriched the life of his adopted country." He was educated at Gordonstoun and served in the Special Air Service. Following this war service, he took his first degree in Psychology at Cambridge in the late 1940's under Sir Frederic Bartlett. On graduating, he worked for his Ph.D. in the same Department, his research at that time making an important contribution to knowledge about the amount of overlap which is possible between perceiving one event and reacting to a previous one. He then spent two years as a member of the Nuffield Unit for the Study of Ageing.

In 1952 he joined the staff of the Applied Psychology Unit at Cambridge and built up an international reputation for his studies on the training and performance of complex skills. Later, he worked with Professor Fitts at the Aviation Psychology Laboratory in Ohio, on some very important studies on information and redundancy in visual patterns.

To quote Dr. Broadbent, " In addition to his other scientific achievements, he had a remarkable talent for psychological apparatus, and much of the work of the A.P.U. has been carried out with equipment designed by him or in close consultation with him. He used also to give a great deal of advice to agencies in the general area of human performance, such as the Post Office, designers of control equipment for the handicapped, and so on. We missed him very much when he left the Unit."

To quote Professor Howarth, " In the early 1960's he became interested in the problems of the blind, and particularly in the difficulties which they have in moving about in an urban environment. His previous work on skill had fitted him technically to study these problems. In addition, his warm and sympathetic character made it easy for him to talk to blind people and to learn directly from them. Characteristically, he did not rely on this gift. He was determined not to allow his intuitive understanding to take the place of the hard scientific evidence — which he obtained from surveys, from observation and from experimental work. Nevertheless, his intuition and sympathy was a very powerful influence, so that in his hands, even the most quantitative and hard-headed experiments were at the same time imaginative, humane and directly relevant to the problems of blind people."

Alfred played a very active part in the introduction of long-cane training in this country and put into practice in Nottingham a systematic attack on the problems of blind mobility. There is the work on maps, on the development of blind children, on balancing abilities, on stopping distances to artificial signals, on the measurement of heart-rate during blind travel, on relaxation, on the adaptation of monaural sonic aids (by mounting the transducers on the head and using the device in conjunction with a cane).

There is the provision of courses for mobility instructors, enabling them to teach the use of sonic aids to blind people. There is also the work on the problems of the deaf blind, various aspects of cane handling techniques, and training schemes in mobility for young people.

To quote again from Professor Howarth, " It is a tragedy that such a uniquely qualified and effective man should have been prevented from completing the work he had planned to do. But we must be thankful that he has achieved so much in such a short time. We can also be grateful for the example he has given of the very direct way in which science can be made to serve human purposes, and of how a humane concern can improve the quality of science."

To quote from the Chairman of a local Nottingham organisation for the blind, " Dr. Leonard did some outstanding research in mobility techniques for blind people. But as well as this, Dr. Leonard had human understanding of the problems encountered by the blind. We sincerely hope his good work will be carried on at the University."

May I add just one personal comment, that in the relatively short period I have known Alfred, I quickly learnt that he was a man of clear purpose and relentless drive. Whenever and wherever he saw a need for action he would immediately plan to do something constructive to solve the problem. He was deeply committed and utterly sincere in everything he did, but his seriousness was tempered with an engaging humour much appreciated by his friends.

It is a fitting start that this Conference should have been named after him.

On the suggestion of the Chairman, all present stood for a moment as a silent tribute to Dr. Alfred Leonard.

The Chairman resumed and said: That concludes the opening part of the Conference. The first session will be chaired by Mr. Douglas Lloyds, Secretary of St. Dunstan's to whom, on behalf of all of you, I should like to offer warm congratulations on his being made a Commander of the British Empire last Saturday in the New Year's Honours List. (*Applause*). I feel sure that this is an honour which is richly deserved. I now ask Mr. Lloyds to be kind enough to take the chair.

Mr. A. D. Lloyds, C.B.E., F.C.A., took the chair and said: Ladies and gentlemen, thank you Mr. Chairman and everyone for your congratulations on the high honour which has been accorded to me. The first paper in this session will be given by Mr. Richard Dufton who is Director of Research at St. Dunstan's. He has had very wide experience in industry and keeps his hand on what is going on, not only in the United Kingdom but throughout the world. I am sure that as his paper unfolds you will realise that a great amount is being undertaken in the sensory field. Mr. C. D. Wills will read Mr. Dufton's paper.

PART I — SENSORY DEVICES

SENSORY AIDS FOR THE BLIND
THEIR DEVELOPMENT AND CURRENT STATUS

by R. Dufton, C.Eng., M.I.Mech.E., Director of Research,
St. Dunstan's.

In the past six or seven years, certain sensory devices have reached the evaluation stage after passing through several phases of development.

There is general agreement amongst researchers in this area that at least four stages are involved from the simulator or laboratory model, to a production engineered batch of instruments large enough to permit meaningful field evaluation.

Prominent amongst user requirements, are compactness and low weight and, if the aid is to be worn, reasonable cosmetic appearance is desirable. From the engineering standpoint, ruggedness, reliability and high resistance to a wide range of climatic conditions are essential, and the researcher is usually working pretty well at the limits of advanced technology in his endeavours to recapture waves of one sort or another from the near environment, or optically, in detecting the images from the printed page. Experience has shown in every instance the specific form of the display to be the most crucial single factor, and investigators evaluating mobility aids especially, have made significant contributions to knowledge in recent years. They have evolved training programmes that permit a flexible approach to teaching blind people new skills through hearing or touch, where total information handling capacity is often said to approximate to 5% of vision.

A period of from five, to as much as ten, years may well elapse to pass through the four stages of development, and in all cases where the production engineering stage has been arrived at, it can be taken that considerable drive, and continuity of effort on the part of the researchers, has been involved, and there is also the decision of a supporting agency that the project merits continuous support. Additionally, there is usually the involvement of a manufacturer undertaking the production engineering. He is faced with onerous decisions in planning the level of tooling to meet the exacting user and engineering specifications already referred to, and the degree of sophistication to employ in selecting or designing key components within the constraints already mentioned. His decisions could have a profound effect both on the evaluation results and the acceptability of the aid. A batch of from fifty to several hundreds of aids may well be involved on reaching the final stage of development, and the majority of these may well have to be purchased by the supporting agency for field evaluation.

PRESENT STATUS.

In the immediate post war years Lord Fraser, Chairman of St. Dunstan's, set up a Sensory Devices Committee to discover if the rapid scientific and technological advances at that time could in any way be turned to the advantage of the blind. The Committee had a distinguished Chairman in Professor Lord Adrian who had, however, to report after three years, " that the Committee was working somewhat ahead of its time in the light of existing knowledge ". Professor Beurle, as a member of St. Dunstan's staff at that time, worked on the Committee's projects, including a study of the Optophone which had been invented in the First World War, and an investigation into blind mobility problems to discover if natural hearing could handle returned echoes from the near environment and so assist independent travel.

It is of historic interest that a cassette based Talking Book system was another of the Committee's projects and, after further development in the Fifties, it became the Mark I model which was only superseded by a light-weight cassette a few years ago.

In the 1950s a serious attempt was made by American researchers, with support from the Veterans Administration, to improve the original British Optophone, and ultimately ten machines were built. However, with modern electronics and additional scanning spots to view thin vertical sections of each letter on the printed page, the only material gain was a reduction in background noise as the reader listened through headphones to the musical patterns of tones and chords characteristic of this type of personal reading aid.

St. Dunstan's still has one of the American Optophones in use — it helps a blind teacher in preparing lessons; while Miss Mary Jameson has made a valuable appraisal of the machine. The project was abandoned several years ago in favour of a smaller version working on the same principle and designated the " Visotoner ". Reading rates, however, may be as low as 8 or 9 w.p.m. after a year's training with machines of this type, with 30 w.p.m. by a few gifted people as a maximum.

The Visotoner, however, is at Stage 4 in development. Forty machines are in use and a similar number may be available in the next year or so. Typescript can be read without removal from the typewriter for the scanning probe is on an extension cable, which also permits the checking of book titles on a shelf. On limited production runs, of the above, it is doubtful if the unit cost could be kept down to £1,000. It may be of interest that a blind computer programmer in London is currently using a Visotoner. There is a tactile version of this direct translation reading machine, but so far reading rates are much lower than for the aural display.

Currently, St. Dunstan's is advised about the kind of research to support by a Scientific Committee under the Chairmanship of Dr. D. E. Broadbent, F.R.S., Director of the M.R.C. Applied Psychology

Unit, Cambridge. The Committee is multi-disciplinary to a degree and comprises psychologists, physiologists and specialists in communications engineering and computer science over a wide field of activities. Close liaison is maintained with researchers in other parts of the world, especially in America, where there are a number of projects at varying stages investigating the problems either of aiding the independent mobility of the blind, or to provide access to the printed page.

Research at the M.I.T., Boston, is well organised with a sensory aids evaluation and development unit, although its main achievement in the past ten years has been concerned more with "terminal devices" such as teletype Braille, computer translation programmes coupled with high speed embossing facilities from remote input information.

St. Dunstan's has given continuous support for ten years to the Sonic Mobility Aid invented by Professor Leslie Kay, including building a prototype and purchasing 50 production engineered aids for field evaluation.

Mr. E. Elliott, a member of our Scientific Committee, and his small team have compiled a Training Manual for the latter aid. It stands as a model in this area and it has been sent to many countries interested in the mobility problem and has also been stipulated as " background reading " for all instructors concerned with the international acceptance trials of the Binaural Sensor mobility aid.

Currently, we are conducting acceptance trials in the U.K. on a batch of 15 Binaural Sensors or " spectacles " — Professor Kay's latest aid. Based on the same echo-location principles as his previous hand held aid, but with wide beam transmission and twin receiving transducers, its output provides bearing information when fed separately to each ear; with pitch/distance again providing range information.

For the past four years St. Dunstan's has supported a project at the Mobility Research Unit, Nottingham University, where the possibilities of alternative body mounting for hand held mobility aids, such as the monaural Sonic Aid — a narrow beam device depending in large measure on accurate kinaesthetic feed back coupled with auditory range information — has been investigated.

Professor Beurle's approach to aiding blind mobility is again somewhat different; investigating the feasibility of using a pulsed system of echo-location and a person's natural ability to localise returned echoes.

There was, however, a concensus of opinion amongst scientists attending the last International Conference on these topics in London, " St. Dunstan's 1966 Sensory Devices for the Blind " that for some time to come, instrumented mobility aids would be most likely to succeed in a supplementary role, that is with a guide dog or long cane as the primary aid.

The final device upon which I wish to comment, is a direct translation reading aid designated the Optacon — optical to tactile converter. After investigating the possibilities of a tactile display for astronauts at blast-off in the early Sixties, when it was felt that hearing and vision might not function too well, investigations commenced at Stanford Research Institute to look at the possibilities of tactile displays. Pulsating air jets were used by Dr. James Bliss, but the astronaut situation did not in fact arise, and he teamed up with Professor John Linvill at Stanford University in the mid-60s to develop an optical to tactile reading aid for the blind.

The aid, now in small scale commercial production, weighs under 4 lb. and comprises three elements; a scanning camera, an electronic section and a vibrating tactile display on which small rods are vibrated to stimulate the index finger of one hand. The stimuli are a one-to-one replica of the optical images viewed by the camera.

The camera has an illuminated lens system which focuses on to a " silicon retina " which has a sensing area about the size of an upper case letter. The sensing area comprises a matrix of 144 phototransistors in six columns by twenty-four, and a whole letter is viewed at a time; the signals passing through the electronics section to stimulate the appropriate patterns of piezo-electrically vibrated rods on the display panel. For example, if one-eighth letter press is involved, the vibrating pattern produces the outline of a letter about half-an-inch in height — an upper case letter is correspondingly greater for the display dimensions are approximately one inch by half-an-inch.

Vibrating frequency has been optimised at 250Hz, with slight vertical movement of each rod as the appropriate pattern of piezoelectric rods is activated. The vibrating rods just protrude through a drilled plastic cover which comprises the display panel. The panel is slightly concave along its length to provide accurate location for the finger.

The optics have a 2½ to 1 magnification, so permitting a wide range of input imaging. There is an " inverter " switch to accommodate white or black input, but the question of type fount does not arise for all characters or symbols can be handled. The best readers in California have achieved 80 w.p.m., which in turn means that they are handling six or seven sequentially presented letters per second.

At the first U.K. demonstration to St. Dunstan's Scientific Committee in June 1971, Professor Linvill's daughter Candy read from *The Times* at about this rate and also read alpha-numerically addressed computer cards. A message, dictated in another room, was also read fluently.

As a result of this demonstration, Lord Fraser has proposed joint action with the R.N.I.B. to set up a training programme in the U.K. early in 1972 with ten Optacons, and this project is already at the advanced planning stage.

The Optacon is more flexible than previously envisaged direct translation machines — input/output sockets in the electronics section permit slave/cable connection to a second Optacon, while there is a visual display enabling a teacher to monitor progress. Tape recorded input signals can also be used to relieve hand scanning the camera along a line of print during training.

Emphasis has been given in this paper to the multi-phase approach in arriving at the production engineered or fourth stage of development. The Optacon seems a very good example of a sensory aid reaching this status. The Stanford capability to design and produce advanced micro-electronic elements has undoubtedly been a key factor in providing several elegant solutions in the production model. Good co-ordination at all stages of development and evaluation are also evident from the fact that training material and ancillary instructional equipment, are available.

After thanking Mr. Dufton for his paper and Mr. Wills for reading it, in the absence of any questions Mr. Lloyds introduced the next speaker and said: Professor Beurle is one of the professors in the Department of Electrical and Electronic Engineering in the University of Nottingham. He has always been interested in and has worked on mobility aids. He is going to talk to us about Pulsed Stereophonic Ultrasonic Aids and has asked that acknowledgements be made to Dr. A. J. Crawford and Mr. J. R. Rudlin for their work on the text.

PULSED STEREOPHONIC ULTRASONIC AIDS

by Professor R. L. Beurle, B.Sc., Ph.D., M.I.E.E., F.Inst.P.,
Department of Electrical and Electronic Engineering,
University of Nottingham.

HISTORICAL.

Guiding aids using both frequency modulated and pulsed ultrasonic beams were made in the U.S.A. and in the U.K. in the late nineteen-forties. Most had a narrow beam and a monaural output, but one pulsed device, constructed at St. Dunstan's, was a wide beam binaural stereophonic device.

All these devices were in the pre-transistor era, and suffered from the weight and bulk associated with valve electronics. A transistorised monaural ultrasonic device was developed in the early 'sixties by L. Kay and was followed by a binaural device with frequency modulated transmission, which is at present under test.

THE PROPOSED DEVICE.

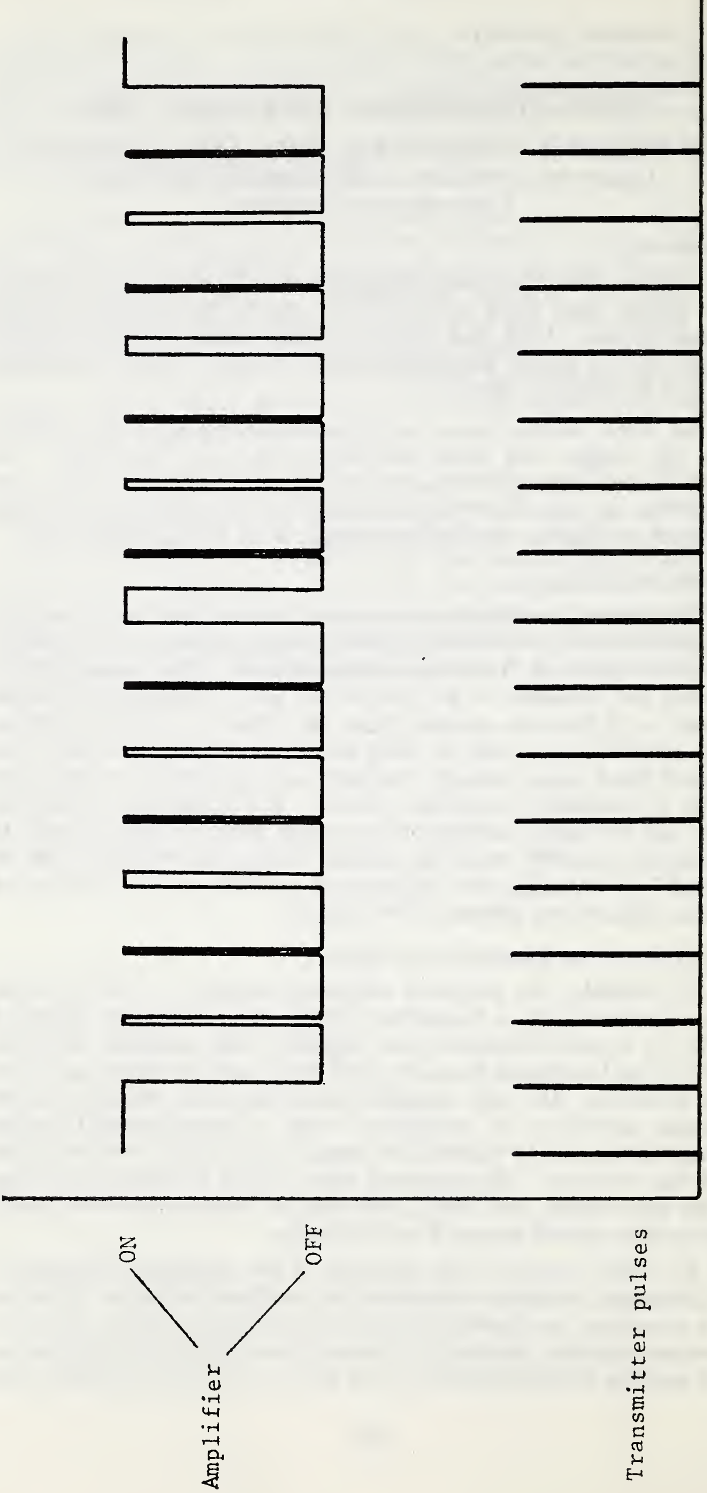
The present investigation is concerned with a wide beam binaural stereophonic device which will transmit ultrasonic pulses and pick up the echoes returned from surrounding objects. The echoes will be detected and presented to the ears of the user as clicks which sound to him as if they are coming from the object causing the echoes. Thus, the blind man will be using his ears in exactly the same way as many blind people already use their ears to detect near objects by means of naturally occurring sounds. The difference is that the effect can be much accentuated by using these artificial sounds to supplement naturally occurring sounds. Moreover, the clicks can be " coded " by switching the receivers on and off, so that the rate of clicking indicates the distance of the object.

CONSTRUCTION OF EXPERIMENTAL DEVICE.

In principle, the proposed ultrasonic sensor is a fairly simple device, incorporating a transmitter which issues ultrasonic pulses of energy at a pre-determined rate, together with matched ultrasonic receivers, and earpieces through which the returning echoes are heard after detection. The only complication arises in the switching of the receiving amplifiers in accordance with a pre-determined coding arrangement, so as to indicate the range of the object from which an echo has returned. The proposed code is that the click rate heard by the user should vary from a low rate for distant objects to a high rate for close objects in, say, five or six steps.

To attain this end, both channels of the amplifier connected to the ultrasonic receiving transducers are switched in unison by means of a waveform synchronised with the transmitted pulses. Figure 1 shows one possible relationship between the amplifier switching waveform and the transmitted pulses, but there are of course innumerable

FIG. 1 — Amplifier Switching Waveform.



other possibilities. The significance of the switching waveform shown in Figure 1 will be made clear by examination of Figure 2, where the "on" periods of this same switching waveform have been expanded in time scale and the waveforms following successive transmitted pulses are shown on separate horizontal lines one below the

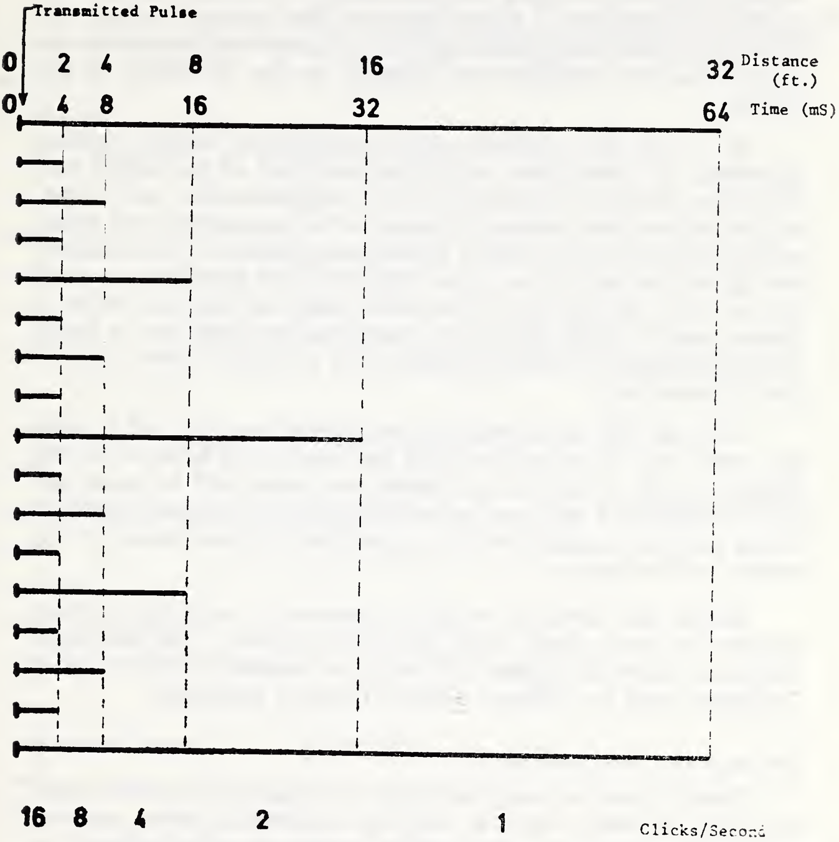


FIG. 2 — Switching Sequence for Receiving Amplifiers.

other. Thus, line one shows the waveform following the first pulse, line two the waveform following the second pulse, and so on. The presence of a horizontal line indicates that the amplifiers are switched on, while the horizontal length of line denotes the length of the "on" period. Starting at the top left hand corner of the diagram, a pulse is transmitted at time t = 0, and the amplifiers are switched on for a period of 64 ms. Echoes from the outward travelling pulse may then be received up to the end of this period. In Figure 2 this period of 64 ms. is marked at intervals of 4, 8, 16 and 32 milliseconds from the transmission of the pulse. Now, sound travels at a speed of approximately 1 ft./ms., so that if an object is situated 1 ft. away from the transmitter, it will take 1 ms. for the pulse to reach the object, and 1 ms. for the resultant echo to get back to the receiver, making 2 ms. in all. It is thus possible to convert the time scale to a distance scale, remembering that it is the elapsed time between the pulse being transmitted and the echo being received that is of interest. The corresponding distance scale is shown above the time scale in Figure 2. So in 64 ms., echoes from objects up to 32 ft. away will be received and heard, since the amplifiers are switched on for the whole of this period.

At t = 64 ms., another pulse is transmitted, which is shown occurring, for convenience, at the left hand end of the second line. This time, however, the amplifiers are switched on for only 4 ms., so that echoes from objects 2 ft. away or less are received and heard, while echoes from more distant objects are suppressed. The amplifiers are off for the next 60 ms., after which the third pulse is transmitted 128 ms. after the first pulse. The other stages of the cycle follow as shown, until 16 pulses have been transmitted, by which time a period of approximately 1 second has elapsed (16 x 64 ms.). After this, the cycle repeats itself.

It is now easy to see that if an object is in the range 0-2 ft. from the torch, then 16 echoes or clicks per second will be heard by the listener; in the range 4-8 ft., 8 clicks per second will be heard and so on, falling to 1 click per second for objects in the range 16-32 ft. These rates are marked for the appropriate distance ranges at the bottom of the diagram.

Clearly this particular switching sequence is only one of many possible sequences that could have been chosen. An alternative example is given in Figure 3, in which a completely different set of 7 clicking rates for different distance ranges is generated.

PRELIMINARY INVESTIGATIONS.

Clearly, there are many factors in the design of this device which are open to choice, such as the basic transmitted pulse rate, the switching sequence, etc. To assist in making the right decisions on these, a series of psycho-physical experiments have been carried out with volunteer subjects. Extensive tests have been designed to determine the ability of the ears to distinguish sounds of the type described. Other tests have been carried out to determine the relative importance of, on the one hand, amplitude difference, and, on the other hand, time differences information in sensing the direction from which a sound is coming. These tests indicated that a combination of both forms of information is optimum.

FUTURE EXPERIMENTS.

Information from these tests is being used to determine the parameters of a portable experimental device which can be used in a more realistic assessment of the merits of this idea. Until these have been completed, it is too early to predict the prospects of this interesting development.

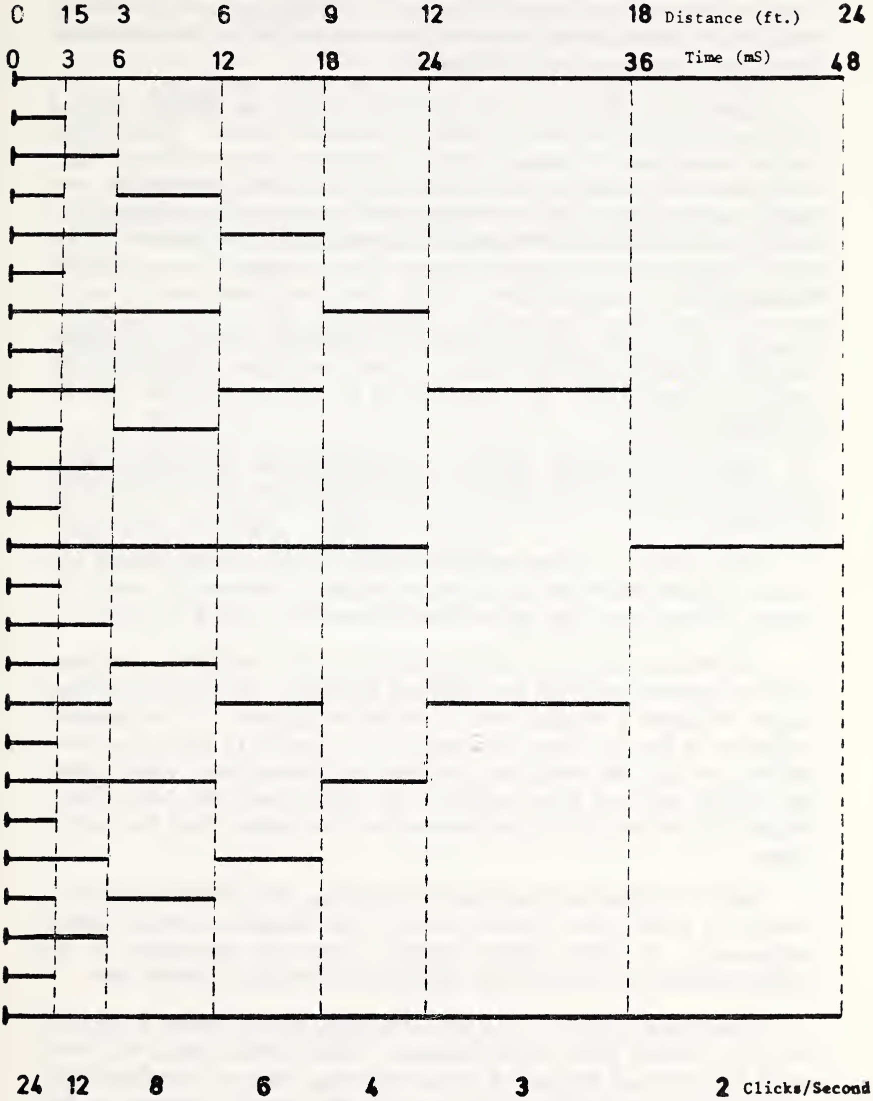


FIG. 3 — Alternative Switching Sequence.

Mr. Lloyds thanked Professor Beurle for converting technical information into clear and understandable language, and invited questions.

Mr. E. J. Venn (Royal National Institute for the Blind): Mr. Dufton said that St. Dunstan's came to the conclusion that sensory aids should be associated with the use of a long cane or a guide dog. With your pulsed devices, do you share that feeling, or do you believe that they should operate by themselves?

Professor Beurle: At the end of the war people were a little optimistic about what "scientific" devices could do. Some of the earlier developers of acoustic, light and various other guiding devices thought that these might provide the complete answer to mobility, and might make guide dogs and long canes and the rest redundant; I think that nowadays our improved understanding has made us much more modest, and we think of these devices firstly as an adjunct to the long cane or the guide dog.

Dr. H. Heath (Dept. Chemical Pathology, University College Hospital Medical School, Lond.): I was not quite sure about the range that was taken. As I understand it, you get 16 pulses at 2 ft. and eight at 4 ft.

Professor Beurle: One can arrange this as one wishes. One possibility is 16 pulses up to 2 ft., eight pulses between 2 ft. and 4 ft., and so on.

Dr. Heath: If there were two objects in that range, would you detect only the object giving 16 pulses which is between 0 ft. and 2 ft. away? Would you pick up another between 2 ft. and 4 ft. away?

Professor Beurle: It does appear to be possible to indicate objects simultaneously at two different distances. If the more distant object produces a weaker echo, it might be difficult. If the impulses are more or less the same in intensity, then, instead of getting uniform pulses, you get one weak one and then one strong one. Also, unless the objects are very close together, the pulses from the more distant object are not precisely superimposed on the pulses from the nearer object.

Mr. W. Thornton (Advisory Committee, Nat. Mobility Centre): Would the pulse system give any idea of the character of the reflecting substance? In other words, would it have the advantages as an environmental sensor that the Christchurch binaural sensor has?

Professor Beurle: The idea of using pulses sprang originally out of a simple little audio-frequency device which sends out very short high-pitched pulses. A pulse returning from an absolutely flat surface such as a smooth wall, is exactly the same in character as the outgoing pulse, but if you direct a train of pulses towards a large bush at a similar distance, you get a separate echo from each leaf and instead of getting a series of single pulses, they are modified so as to give a distinctive sound related to the texture of the object.

While experimenting with the clicking device, we found the variation in sound quality with texture extremely valuable. We expect the same to be true of this ultrasonic stereophonic device.

Mr. T. J. Parker (Nat. League of Blind and Disabled): A lot of concentration to date has been on conveying information in a tactile sense. I think that many blind people get a great deal of information by tactile means, and are concerned that this should not be interfered with. For the average blind person, especially one with normal hearing, it would be a help — and it would be a Godsend to the deaf-blind — if information could be conveyed other than by sound.

Professor Beurle: I am sorry, but I think the very detailed and subtle information from these devices would be difficult to convey in a tactual form. On the other hand, we do not want to obstruct the ears, and in any case the pulse device provides sounds for the blind listener which are very similar to those that the blind person normally uses. To the blind person who can walk beside a hedge using reflected sound, this device would just accentuate the type of sound he already uses.

In introducing the next paper which was compiled by Mr. N. V. Clarke, Mr. G. F. Pick and Dr. J. P. Wilson and would be read by Mr. Graham Pick, on the subject of A Sound Obstacle Detector, Mr. Lloyds said: Mr. Pick is at the Department of Communications in the University of Keele. I believe that this is the only Department of Communications in the United Kingdom.

SOUND OBSTACLE DETECTOR

by Dr. J. P. Wilson, B.Sc., Ph.D.; Mr. G. F. Pick, B.Sc.; and
Mr. N. V. Clarke, Department of Communications,
University of Keele.

The aim of the investigation was to develop and evaluate a device which enhances obstacle detection by echolocation.

THE AID.

The device, designed to produce enhanced echoes, was made in the shape of a torch with a separate battery pack (see Fig. 1). A fairly directional electrostatic sound generator (1) was used, designed to improve spatial resolution. It generated white noise, which was gated (with equal mark/space ratio at about 6 pulses/s.), in order to provide echo delay information. Users were instructed to carry the device at about hip level in order to reduce the amount of direct sound at the user's ear. Wind and ambient noise proved to be a problem in outdoor trials.

EXPERIMENTS.

The aim of the experiments was to evaluate the device as a training aid for echolocation, and as an everyday mobility aid. The subjects and obstacles used are shown in Tables I and II respectively.

TABLE I — SUBJECTS

Group	*Description*	*Age*	*No. of years blind**	*Where tested*
Blind Children	2 boys + 2 girls	12-14 years	10	Blind school library.
Long-time blind	4 men	middle aged	10	Blind workshop† assembly hall office suite‡
Short-time blind	4 men	middle aged	1-3	Blind workshop† office suite‡
Blindfolded sighted	4 men: 3 authors + 1 technician	25-45 years	0	Keele Blind school library†

* No subject was blind from birth.
† 1st mentioned venue for experiments I-III.
‡ 2nd mentioned venue for experiment IV.

Table II — Obstacles

Shape	*Dimension*		*Surface Material*
Plane board	180 cm. high 120 cm. high	90 cm. wide 30 cm. wide 15 cm. wide	sized hardboard
Cylinders	160 cm. high 140 cm. high	23 cm. diam. 7 cm. diam.	galvanized iron polished plastic
Step ups/ Kerbs	90 cm. long, 1 =	20 cm. 13 cm. 5 cm.	sized hardboard

Experiment I compared how well subjects could detect the variety of obstacles with and without the aid. Obstacles were arrayed about the subjects at a variety of directions and distances. Subjects were asked to rotate on the spot and stop and point at obstacles when detected. The mean for six trials for each subject and obstacle was recorded. As might be expected, those obstacles which gave the best specular reflections were the most detectable. When using ambient noise alone, the groups which presumably had the greatest experience of echolocation (by virtue of the length of time blind) did much better than those with no need for echolocation With the aid, all subjects detected about the same number of obstacles. It seems that the device aids even those who are not particularly good at echolocation.

Experiment II was performed to determine how great an angle a plane obstacle could be turned before it became undetectable. One would hope that a mobility aid would help a blind person to detect angled surfaces. The board angle was varied until it was just detectable. Even a 90 cm. wide board at a distance of 1·5 m. failed to be detected at an angle of only 18 degrees. This is of course a limitation of all devices, sonic or ultrasonic.

Experiment III was to investigate whether subjects could determine relative distance. This ability would be of help in forming a mental map of the immediate obstacle environment. The experiment is illustrated in Fig. 2. The obstacles were placed at the same or different distances from the subject, who judged the nearer of the two obstacles. A " left, further " response is recorded as a negative proportion. Fig. 2C shows that the subjects responses do not always reflect the true spatial configuration. It seems that the development of an accurate map of the environment may be beyond the powers of echolocation.

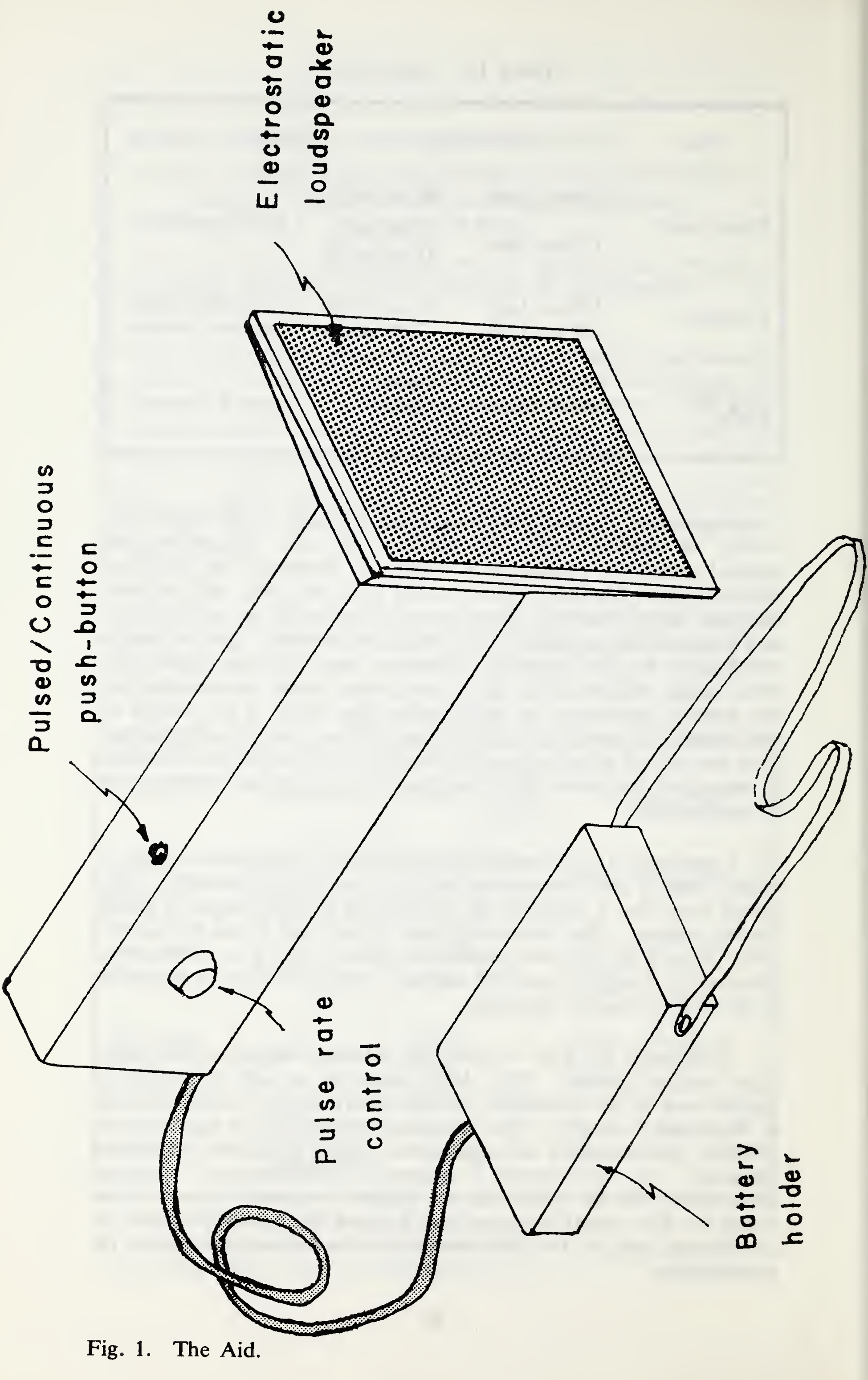

Electrostatic loudspeaker
Pulsed/Continuous push-button
Pulse rate control
Battery holder

Fig. 1. The Aid.

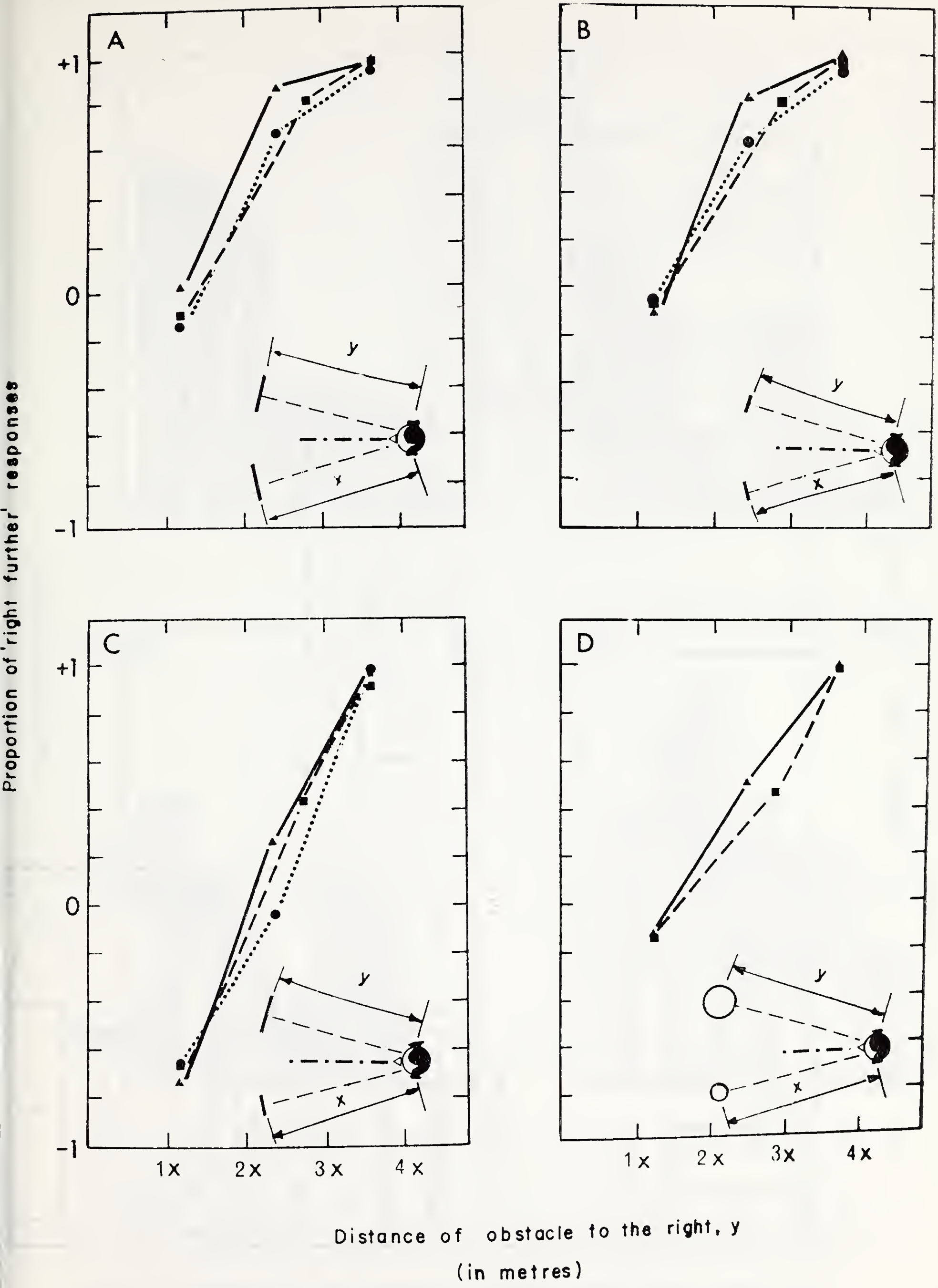


Fig. 2. Results of Experiment III averaged over all subjects.
x = 122 cm., x = 183 cm., x = 244 cm.

A. Comparison of two 30 cm. boards.
B. Comparison of two 15 cm. boards.
C. Comparison of 30 cm. board with 15 cm. board.
D. Comparison of 23 cm. pipe with 7 cm. pipe.

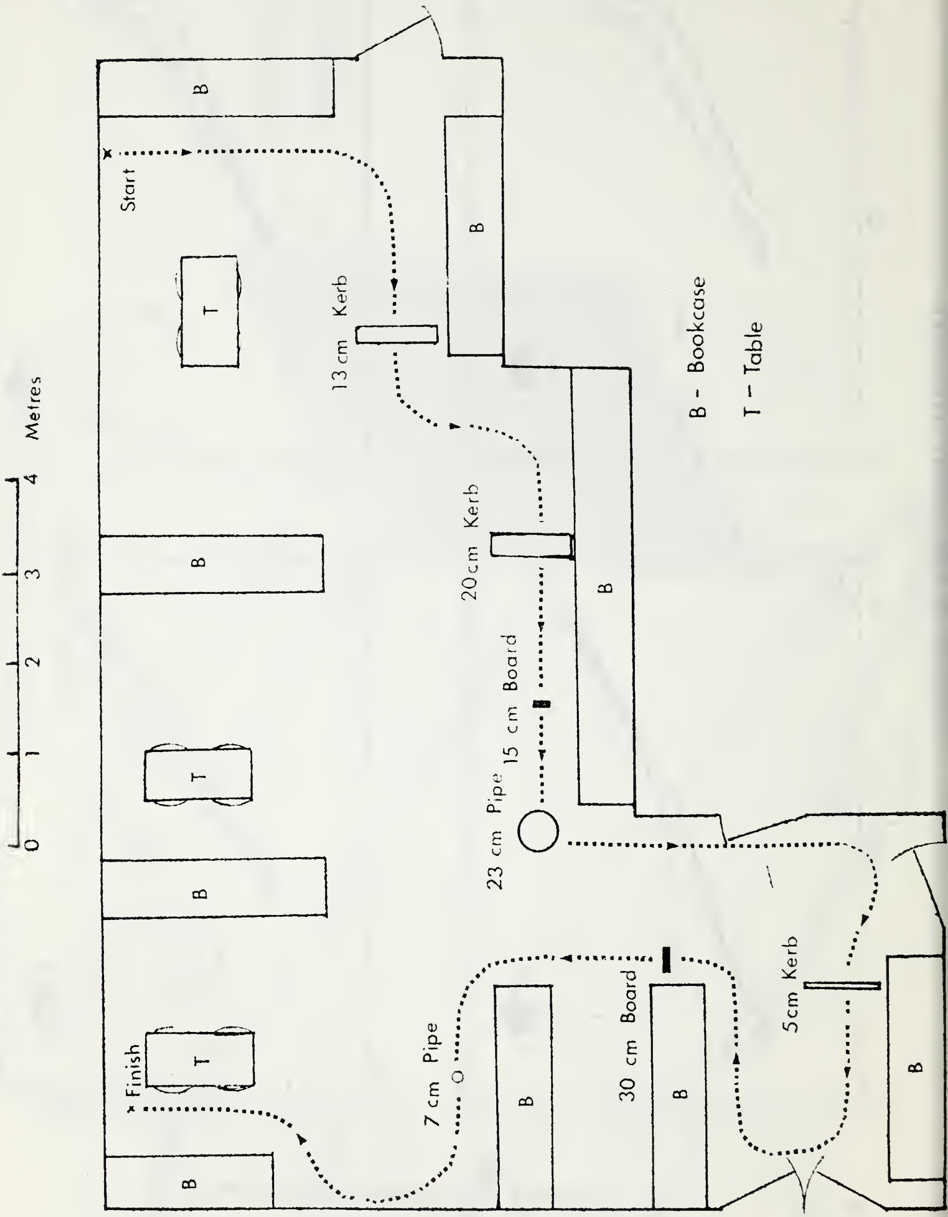


Fig. 3. Typical obstacle course layout at Blind School.

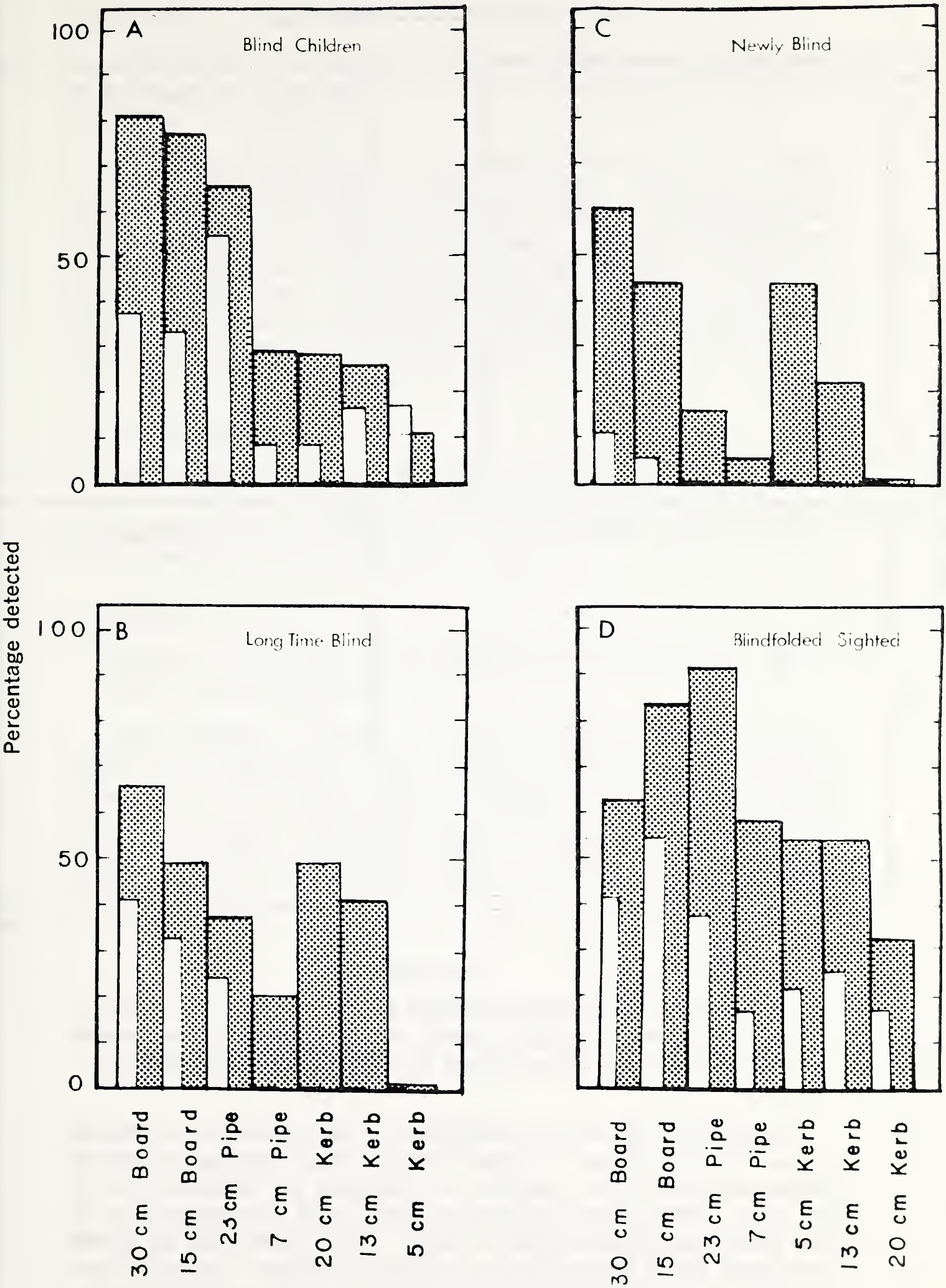


Fig. 4. Proportion of obstacles detected with and without aid (Experiment IV). Shaded bars show the percentage detected with the aid, the narrower unshaded bars show percentage detected without aid.

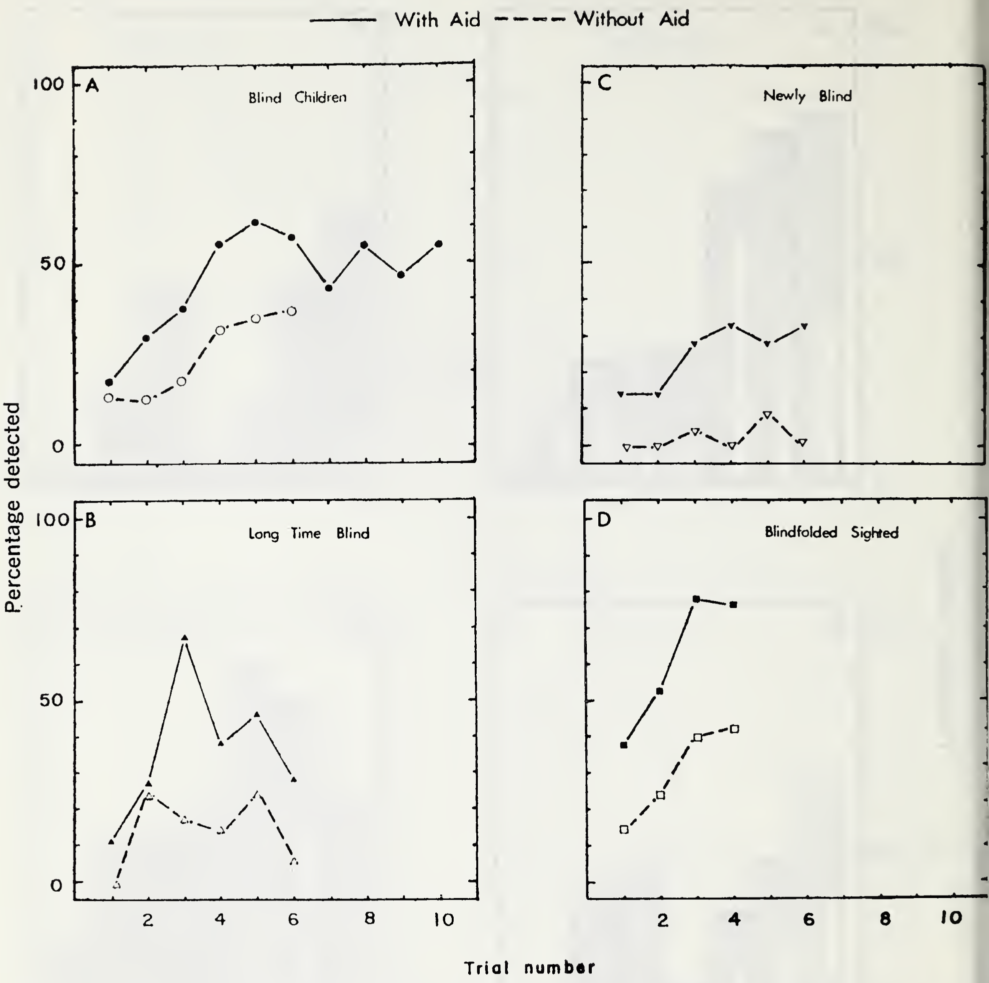


Fig. 5. Aggregate percentage detected in Experiment IV as a function of trial number. Points joined by a continuous line indicate results with aid, points joined by broken line those without.

Experiment IV was an evaluation of the device in an obstacle course. Fig. 3 shows a typical course which subjects negotiated. Preliminary tests were designed to familiarise the subjects with the test room. They then negotiated the course, with and without the aid. The results are shown in Figs. 4 and 5. Fig. 4 shows that all groups performed much better with the aid than without. Obstacles were detected at a greater distance with the aid. Fig. 5 shows rapid learning with and without the device. This result might imply that learning with the aid enhances obstacle detection by echolocation without the device.

DISCUSSION.

Experiments I and IV show that there is improved echolocation with the device, even for subjects who presumably had considerable experience of echolocation.

Fig. 5 indicates that the device should be effective as a training device for the newly blind and blind children. The aim of this training would be to develop echolocation abilities by self-generated and ambient noise. It appears from Fig. 5A, that blind children can locate almost as many obstacles without the device as with, after training in this way. The results suggest that specific training in echolocation would be worthwhile. A simple device of this kind could be produced cheaply and a reduction of bulk and power requirements should present no problems.

ACKNOWLEDGEMENTS.

The work described in this paper was supported by a grant from the Wolfson Foundation, for which we are very grateful. We would also like to acknowledge the technical assistance throughout the project of Mr. J. B. Ruscoe.

REFERENCE.

1. Wilson, J. P. " High Quality Electrostatic Headphones ". Wireless World, 440-443 (Dec. 1968).

After thanking Mr. Pick and finding that there were no questions raised Mr. Lloyds said: The next two papers are by scientific researchers at the Blind Mobility Research Unit at Nottingham University. First, we have Dr. Heyes, who is to speak about a new ultrasonic mobility aid for the blind. In addition to work on this mobility aid for the blind, Dr. Heyes is also very much concerned with research for deaf-blind persons.

A VERSATILE ULTRASONIC MOBILITY AID FOR RESEARCH PURPOSES

by Dr. A. D. Heyes, B.Sc., Ph.D., Blind Mobility Research Unit, University of Nottingham.

Neither the long cane nor the Kay Sonic Torch give full body protection and because of this the possibility of using two aids at once has been investigated at length. I refer to John Armstrong's head mounted version of the Kay Sonic Torch, the Kay binaural spectacles and more recently the aid I am going to describe today. In all these systems the long cane is the primary aid and the electronic device the secondary aid.

Dr. Armstrong found using a modified Kay Sonic Torch as a head mounted secondary aid that much of the informational content of the signal was not used and that essentially the subjects were using the secondary aid as a clear path indicator merely to give warning of the presence of objects. The informational content of the original Kay Sonic Torch is very rich in that it is a multiple target device and in that it contains textural information. The aid in fact can be justly described as an environment sensing device. As such it is a useful primary aid for the small number of people who are able to make use of all the information. When used as a secondary aid, however, a much depleted display has been found to be of more value.

Many users of the Sonic Aid have suggested that the " coding " is wrong, for example, they have suggested that it would be more natural if, instead of displaying frequency, the auditory signal increased in loudness as an object approached. Yet other systems have been suggested and quite clearly there was a need for an investigation of, what I shall call, display — the way in which the aid portrays the information to the blind traveller.

On the basis of the above suggestions, the findings of Dr. Armstrong and experience of the Blind Mobility Research Unit, it was decided that an experimental aid should be constructed incorporating the following features: —

1. A range of 7·5 ft. (2·35 m.).
2. A beam width of 2 ft. (·63 m.) — shoulder width — at 6 ft. (1·85 m.).
3. No output from the device in the absence of a target in the beam.
4. Six discrete distance zones ; the presence of an object in a zone activating the appropriate one of six electronic switches.
5. An inhibit device such that in the presence of more than one target only one of the electronic switches is activated and that being the one corresponding to the target nearest the subject.

Thus, the main differences between this new aid and a head mounted version of the Kay Sonic Aid are ; it is " silent " in the

Fig. 1

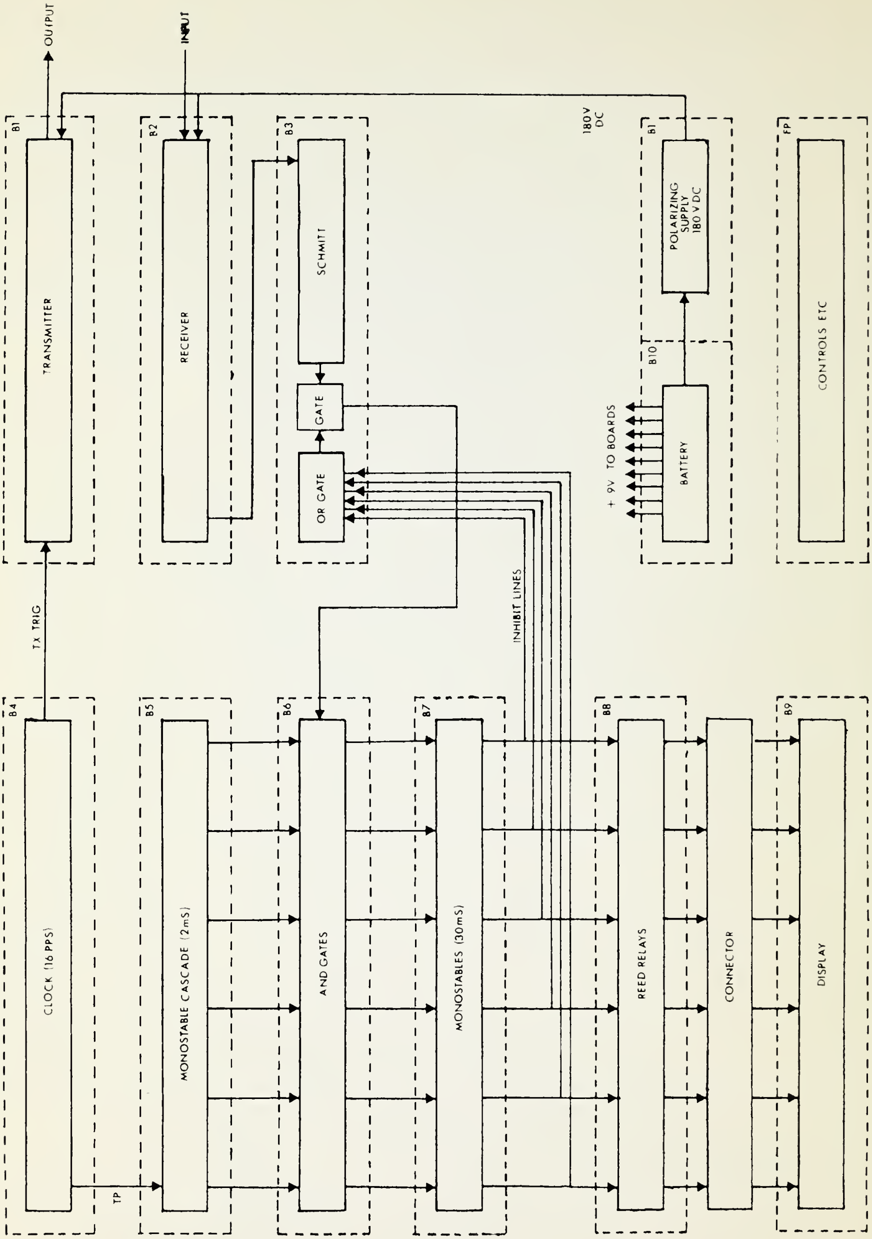


Fig. 2 BMRU PULSE ECHO AID

absence of a target, it is a one target device and the range information is quantized rather than being continuous.

The six ranges used in the aid are set in the following way; five one foot wide gates are centred on 1 ft., 2 ft., 3 ft., 4 ft., and 5 ft and one 2 ft. wide gate centred on 6 ft. 6 ins. The electronic relay outputs were chosen so that an infinite variety of displays could be evaluated with the aid. No attempt was made to make the aid cosmetically acceptable nor was excessive miniaturization aimed at. Rather the aim was to make it robust and cheap.

We were able to commandeer several parts from the Kay Sonic Aid. We used the transmitter, the receiver, the bias voltage supply and the transducers. The transducers were attached to a head band and mounted on the forehead as shown in Fig. 1. The transmitter was modified so that it operated at a single frequence (50 KHz) which could be pulsed in 0.25 m/sec. bursts. The receiver was modified to give peak sensitivity at 50 KHz and so that it had a direct coupled output into a Schmitt trigger circuit.

Referring to Fig. 2, a free running multivibrator provides the main timing pulses of 16 Hz. Each pulse fires the transmitter and at the same time begins a chain of seven mono-stable trigger circuits. The first of these is on for 1 m/sec. and corresponds to the pause time before the echo pulses are expected. The second to the fifth of the mono-stable trigger circuits are on for 2 m/secs. each and the seventh for 4 m/secs. The outputs of these circuits go to six two input AND gates and the other inputs to the AND gates being commoned and coming from the output of the Schmitt trigger circuit. The coincidence of an output from the Schmitt circuit, corresponding to a received echo above a predetermined threshold, and the output from one of the chain of mono-stable circuits causes the appropriate AND gate to give an output. This fires a 30 m/sec. mono-stable trigger circuit — a time equal to half of the repetition rate of the master clock — which does one of two things; it closes the contacts of the appropriate output relay and also inhibits the signals coming from the Schmitt trigger circuit so that none of the other AND gates will be able to give an output.

If we remember the rule of thumb that sound in air travels at one foot per m/sec. we can see that, using the times listed above, the cascade of mono-stable circuits and the subsequent AND circuits enable the receiver output to be gated into the six desired ranges.

So far in our two experiments completed to date the six relays have been used to switch on six different frequencies — decreasing in pitch as the object is approached — and six different loudnesses — increasing in loudness as the object is approached. The next form of display to be investigated will be one involving mild electric shock stimuli to the skin.

In Dr. Armstrong's paper which follows he will describe a generalised evaluation technique for mobility aids. The techniques evolved by Dr. Armstrong are being used in connection with the work on displays described in this paper.

A grant in support of the work described in this paper was given to the Blind Mobility Research Unit by St. Dunstan's.

Mr. Lloyds thanked Dr. Heyes for his paper and asked Dr. Armstrong to follow with his, so that questions might be put jointly at the end.

EVALUATION OF MOBILITY AIDS

by Dr. J. D. Armstrong, B.Sc., Ph.D., Blind Mobility
Research Unit, University of Nottingham.

During the past decade, something like a dozen new mobility aids have appeared in the U.S.A. and the U.K. Most of these aids are electronic devices and, with the exception of only one of them, they are all still at either the prototype or evaluation stage.

Since none of these devices are, or in fact claim to be, the final solution to the mobility problems of the visually handicapped, there is an obvious need to establish some technique for their evaluation.

There are three major reasons why evaluation is necessary:

1. To make definitive statements about the usefulness of individual devices as aids to mobility. We need to know what can and cannot be expected of a particular device in the mobility situation.
2. To isolate the reasons for the failure of a specific aid to provide necessary mobility information. By isolating the shortcomings of a specific device we will be able to ensure that such failures are not repeated in future developments.
3. To provide both the agencies for the visually handicapped and the mobility instructors with adequate information about performance of the various aids available so that the most suitable aid and accompanying training for the client might be prescribed.

At the present time, most of the information which is available about devices is the result of evaluations carried out by the inventors or developers of those devices along with the occasional reports from a few users.

There are very good reasons why this type of evaluation does not normally provide information required under the three headings above. The inventor usually adopts evaluation procedures which are intended to compare the performance of the device with its original specification. This type of evaluation tends to be an ongoing process which accompanies the development of the device.

Even when an inventor considers his device in mobility terms the evaluation is still very much coloured by the nature of the aid itself.

Thus, it is argued that there is a great need for the development of an objective evaluation technique which is capable of assessing the performance of a device purely as an aid to mobility.

One of the first attempts at the development of such a technique was made by Leonard & Wycherley (1967). At that time Leonard & Wycherley advanced a number of " specifiable criteria " for blind travel.

These criteria referred to both broad and specific activities normally observable during blind travel. An attempt was made to analyse the performance of a traveller in terms of these criteria in an experiment carried out in Shrewsbury with children from R.N.C. In spite of the practical difficulties of scoring performance whilst following hard on the heels of the blind traveller and the fact that the measures relating to the chosen criteria were, for the most part, not sufficiently sensitive, there did emerge a reasonably clear profile of the activity of the traveller over the route. Leonard & Wycherley admitted that " . . . this was by no means a perfect job (but) we would submit that this represents a more objective manner of assessing travel skill than any reported so far ".

Since 1967, work on the development of more powerful performance measures has been intensified at the Blind Mobility Research Unit. The availability of portable and inexpensive video recordings equipment has almost totally reduced the practical problems of scoring specific events on the route and a permanent record in this form can allow detailed inspection of such events which, in a real time setting, would have been impossible.

The present evaluation technique was principally developed in order to assess the usefulness of the head-mounted version of the Sonic Aid (see Armstrong, 1970). It has obviously been strongly influenced by the Leonard & Wycherley study but it is much more specific in its measures relating to mobility criteria. However, like the 1967 study, its measures are independent of the device or training being evaluated.

Three major dimensions of mobility performance have been specified. They are (1) safety, (2) efficiency, (3) psychological cost. These will now be considered in more detail.

1. SAFETY. The blind traveller, with or without an aid, must be protected from physical damage. Whilst on the pavement, he must be prepared to encounter obstacles originating at ground level at any position on the pavement and obstacles which overhang or protrude into the pavement space. He must also avoid stepping into the roadway by accident. When crossing roads, he should at least be as safe from damage from motor vehicles as sighted pedestrians.
2. EFFICIENCY. If he so wishes, the blind traveller should be able to cover the distance between two locations by the shortest possible route and in the shortest possible time.

   To achieve this end, the traveller must be aware of both his position and orientation with respect to the route as a whole and his position and orientation with respect to his immediate environment.
3. PSYCHOLOGICAL COST. The traveller should not be caused unnecessary stress as the result of using a particular mobility aid or technique. Ideally such an aid or technique should reduce the level of psychological stress observable in blind pedestrians (see Peake & Leonard, 1971).

Specific measures have been evolved so that the blind pedestrians performance can be related to the three dimensions.

The process involves scoring mobility performance in sixteen categories, each of which relates directly or indirectly to the efficiency and safety of progress. Two other measures, so far not well developed, are intended to indicate the level of psychological stress experienced by the traveller.

The actual scoring procedure is lengthy and will be published in due course.

The evaluation technique should be capable of providing an overall measure of performance in a number of experimental situations. It should be useful in the base line evaluation of a specific device (i.e. performance with the device versus performance with no device), in the direct comparison of different aids and in the comparison of different training programmes for individual aids. Alternatively, it could provide an objective measure of the performance of the traveller himself.

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PEAKE, P. & LEONARD, J. A. (1971) The Use of Heart Rate as an Index of Stress in Blind Pedestrians. Ergonomics, 14, No. 2, pp. 189-204.

Mr. Lloyds then invited questions on the two papers.

MR. G. SLAUGHTER (The Nat. League of Blind and Disabled): How efficient are these sonic aids where there are a number of moving targets, for instance, when a person is walking along a high street? How proficient can a person become in using the aid in such circumstances?

DR. ARMSTRONG: Well, I have used this aid myself. I am not blind, but I think that people in the Blind Mobility Research Unit have spent sufficient time blindfolded to appreciate most of the difficulties that blind persons have in street situations. My personal idea — and this is reflected by others — is that, even in a crowded street situation this is very useful. When used with a long cane, this gives a stride and a half warning and this device has a range of 7 ft. It allows you to do a little bit of route planning and to get around prams and lamp-posts and so on and you can weave your way around things when making cane contact. This just helps you that little bit extra. Obviously, there are situations where there are problems. On a number of occasions I have seen little old ladies looking in shop windows; the person using the device comes along and picks up the reflection of the lady, but then she jumps away from the window into the traveller's path.

Dr. H. Heath: Why did you limit your range to six or seven feet? One person approaching another takes two feet and the other takes three and there is not much room left.

Dr. Armstrong: The longer the range, the more likely it is that you will pick up objects which are not of concern to you. You may be walking through a clear channel and the long cane will be protecting you on a low level. You are interested only in the immediate information. I agree that the question of meeting pedestrians is difficult if a person is walking quickly; you may get very little warning.

Dr. Heath: I think the range would be better if it were longer.

Mr. S. O. Myers (University of Birmingham): Do you use your test run of 40 minutes for training purposes as well?

Dr. Armstrong: No. There is a little problem here. We started using artificial routes and found them unsuitable. It was better to go out into real life situations. If you make an artificial pavement, there is a tendency to cram in all the obstacles that you think the device might detect, resulting in unreality. Then the person does rather badly. One comment which Alfred Leonard always made was that street situations have a meaning to them which artificial situations do not have. Training takes place on routes with the sort of complex that the blind person is likely to encounter.

Mr. J. A. Wall: Have you thought of evaluating the environment by looking, not at an artificial but an actual street, and seeing how much obstruction is above waist level? My guess would be that in a city street there would not be much because there would be no low branches of trees.

Dr. Armstrong: When I started investigations, I thought that there would not be a great many situations like that, but I had no difficulty in finding places where residents did not obey local byelaws and trim hedges and so on. Wet leaves present a very awkward hazard.

Mr. R. Dufton (St. Dunstan's): On the question of wet leaves, the branches of a tree take up a position four to six inches lower when the leaves are wet than when they are in a dry condition.

Mr. Wall: I find when walking under trees on a wet day that I can have six hair washes (*laughter*).

Dr. Armstrong: Protection of the upper part of the body does not so much affect the younger blind person who can rely on his natural awareness, but for a person over 40, say, it is more difficult.

After expressing gratitude to Dr. Heyes and Dr. Armstrong for the work they were doing, Mr. Lloyds said: From mobility we move to reading aids. Professor Uttley is a very old friend of St. Dunstan's. He has been connected with us since the late forties when he was a member of our scientific department and he is now at the Laboratory of Experimental Psychology in the University of Sussex. He will talk about his work on a personal reading machine for the blind.

THE ST. DUNSTAN'S READING AID PROJECT

by Professor A. M. UTTLEY, B.Sc., Ph.D., Laboratory of Experimental Psychology, University of Sussex.

The idea of converting print into sound began with the Optophone in which a vertical array of flickering light spots was moved along the line of print. A photocell picked up the total reflected light so that a vertical line generated a chord and a sloping line an arpeggio. Four or five different musical sounds were generated by each letter; in contrast speech generates less than one phoneme per letter. Consequently, the speed of Optophone reading is only about a tenth of sighted reading.

A machine for recognizing printed characters costs in the order of £100,000; for an additional £100,000 it could generate real speech Such a machine, because of its intrinsic high speed might serve the needs of a whole country, turning out talking books on demand, from some central organization.

In contrast, a simple and cheap machine could be built to recognise only the basic features of a character, its corners, junctions, free ends and so on. It was suggested some years ago that such a machine might be made to generate the basic features of a phoneme, its formats, transitions, noise bursts and so on. The cost of such an instrument, when in production, might be that of a car; no more accurate figure is possible at present. The idea has been the subject of St. Dunstan's Research for the last four years.

It was early decided that speech-like, rather than non speech-like, sounds should be generated, firstly, because they can be varied in very many different ways compared with the Optophone and its successors; secondly because the brain will have already adapted to recognise this rich vocabulary of sounds. Furthermore, because there are only about 45 phonemes and at least 62 alphanumeric characters, allowing for numbers, capitals and lower-case letters, it was decided to represent each character by a consonant-vowel pair. Phonemes have been synthesised by rule on a general purpose digital computer.

The major difficulty of the project has been that if, say, fifty optical features were used to generate fifty auditory features, they would have little probability of being assembled in the right way. A letter A, for example, might possess features 10 to 15 in an optical list. But the corresponding auditory features 10 to 15 might produce a nonsense. However, the 50 cross connections could be made in 50 factoral ways, while for 26 letters, there would be 26 factoral ways of associating them with 26 phonemes. To avoid these astronomical figures it was essential therefore to narrow the problem by picking a minimal number of key optical features which would uniquely describe the alphabet; ten were chosen. Similarly, the task was reduced to that of generating only 10 sounds from 10 key letters. Even so, this meant that there were a thousand million million possible connective arrangements, of which the most speech-like should be chosen. This problem has actually been solved, by massive use of a digital computer and various valid short-cuts. Ten good synthetic consonant-vowel (C.V.) pairs have been generated from ten lower-case letters from the typical Penguin fount. The remaining sixteen letters also give speech-like C.V. pairs because their optical shape is similar to that of the ten key letters; for example an "h" *must* sound like a "b". It was important therefore, to choose the ten key letters so as to be as different as possible in shape.

Preliminary psychological experiments on a small number of letters show that learning to distinguish the synthesised consonant-vowel pairs is rapid and that the final accuracy is of the order of 19 correct out of 20; a full assessment is the subject of present work.

Mr. Lloyds thanked Professor Uttley and invited discussion.

Mr. E. T. Boulter (Royal Nat. Inst. for the Blind): I know nothing about this and I may well be expressing my ignorance, but is there any advantage at all in using an existing code for letters, such as the Morse Code? Is there any advantage in producing the Morse equivalent?

Professor Uttley: This is not possible; to use the Morse Code the machine would first have to recognise the letters. I explained in my talk that this would cost at least £100,000. The whole aim of this research is to avoid this and produce something the blind man might afford to buy, to read any book. This has been achieved.

Dr. A. D. Heyes (University of Nottingham): I did not gather whether this piece of apparatus has a time limit to recognise a letter.

Professor Uttley: In principle there is no limit to the speed of recognition; but there is a limit to the speed at which the phoneme output can be emitted and recognised. We are thinking of something like 80-90 words per minute.

Dr. Heyes: Thank you. If you wanted to use the Morse Code, you would have to recognise the letter and then give the output.

Professor Uttley: You see, it is this recognition of what the letter is that can cost £100,000. We say, very loosely, that the proposed machine might cost as much as a car and we will not go further than that.

A Lady Member from London: There are two different sorts of question that I wish to ask. The first is whether there would be a problem with different forms of print. Would there have to be a standard form of print?

Professor Uttley: Let me answer that straightaway. Because we have all the programmes written and working for adapting to any fount, it would be a question of fitting in another tape — shall we put it that way — and the machine could then recognise another fount.

The Member: The other question I want to ask — this may be a little premature — can you tell us what, for example, a word sounds like?

Professor Uttley: Yes, but not tonight. We have done it at Sussex. I did not say anything about the transitions, the changes which occur in your mouth when you change from a consonant to a vowel. For a word, you have a transition to join the letters together. We have done this, but at the moment on our computer we cannot produce more than two seconds worth of continuous speech. For this research we do not need to do more.

Mr. Lloyds thanked Professor Uttley for his very technical explanation and announced the paper on Sensory Devices, given by Dr. Clowes, who was for some time working on reading machines. Recently he has been to Australia with the Commonwealth Scientific and Industrial Research Organisation doing some work on computers, I believe. Now he is back in this country at the University of Sussex

KNOWLEDGE-BASED BEHAVIOUR

by Dr. M. Clowes, B.Sc., Ph.D., University of Sussex.

Dr. M. Clowes, B.Sc., Ph.D. (University of Sussex): Thank you, Mr. Lloyds. My field of research, Artificial Intelligence, is at first sight rather remote from research on blindness with which I have had in the past a strong connection through the St. Dunstan's research projects.

Briefly my work concerns programming a computer to see. The input to the computer is via a television camera, and the sort of things I want it to see are assemblies of play blocks such as a child might build. The computer programme has to make sense of the T.V. image — an array of points, each of which is a shade of grey represented as a number — as blocks of particular shape leaning against or standing on other blocks, obscuring one another, some blocks butted together, others forming rows, etc.

Programmes have been written which will perform this task, i.e. output a description of the locations (in three dimensions) of the objects it can see, sufficient for a simple hand controlled by the same computer to build a copy of the scene, rearrange it or even to move about in it (a very simple robot on wheels, built in California). Such research might be thought relevant to blindness in pointing the way to advanced prostheses (a robot guide dog!) were it not for two things. The first is the incredible cost of such systems (hundreds of thousands of pounds). More important however is their total inadequacy, and it is in the formulation of that inadequacy that their relevance to blind research really lies.

The basic feature of these systems is that they are *hierarchic*. By that we mean a series of processes connected as it were, end to end. The first process attempts to find local changes of contrast in the T.V. image. The next to connect these changes into straight lines. The next to find where these lines meet — junctions — and the regions that they bound. The next step attempts to decide which regions belong to the same body, and then to try to match these sets of regions against prototypes whose detailed three dimensional shapes are built into the programme. This works for a scene without visible shadows and blocks without surface markings. In practice even such scenes cannot be well lit, and lots of edges will not give rise to nice contrast steps, and shadows and obliquely lit surfaces will give rise to spurious changes of contrast. The early processors cannot find edges that aren't visible in the picture; neither can it ignore these artefactual edges. What these early processors need is to be *guided* by the requirement that the whole T.V. image makes 3-D sense in selecting and forming lines, junctions, and regions. But to provide this guidance we have to destroy the simple sequential structure of the programme so that for example some edges are guessed because a particular prototype then makes sense of that area of the picture. In turn this helps to figure out where the light is coming from (the missing edge belonged to two surfaces equally inclined to the light), which enables the programme to decide that another black region is a paint mark and not a shadow. This idea that even the most primitive early perceptual decisions involve meaning, and cannot be left to context free pre-processors is of very great importance. It has been called *heterarchy* in contrast to hierarchy. Firstly because it faces the robot researcher with a very difficult task, second because it contains a message of great importance for the design of sensory prostheses and the training of the sensorily handicapped.

When we read, we do not recognise each letter in isolation rather we make use of what we have understood to select new parts of the text and to provide expectations about the words and hence letters we expect to find there. This is precisely the heterarchical pattern I alluded to in the scene analysis I described, and the partitioning of the print into letters and their subsequent recognition cannot be reliably accomplished without this involvement of expectations. Existing reading machines succeed only by careful control of print quality (compare with careful control of lighting) and all are constructed on a hierarchical principle. The opticon is a notable counter example: it attempts no recognition and provides what would appear to be maximal scope for the deployment of the heterarchical skills of the human reader. Specifically, it permits the reader to freely access different parts of the page — an essential freedom if meaning is going to play a role in selecting what to look at — and is in marked contrast to various optophone arrangements which incorporate mechanical tracking. Candy Linvill's performance is not essentially different from that of a sighted person who has taken a speed reading course which encourages you to look only at those parts of the page that are necessary to pursuing the meaning of the text. The limited recognition system being developed by St. Dunstan's can, I think, be criticised on just these grounds: insufficient attention has been paid to its integration into the heterarchical skills of the user. It is, of course, a strictly hierarchical device.

This " message " was one which Alfred Leonard was well aware of, his long report on his researches into mobility contains several passages in which he stresses the need to understand how one's expectations of the natural world enter into the sensory information available to the blind traveller. He stressed the need to devise training methods to persuade the blind traveller to utilise his knowledge of the world so as to identify new varieties of cue, i.e. to bring expectations to bear upon the interpretation of the raw sensory input. It is perhaps not too strong a conclusion to draw from the advanced technological studies I have described, that *the best hope for research into the amelioration of blindness lies in the study of the blind person, not the invention of new complex prostheses.* Specifically into understanding the nature of the skills of which we are capable. Alfred Leonard recognised this earlier than most: perhaps he would forgive me for going on to say — and the best way to understand these skills is to try to programme them!

Mr. Lloyds thanked Dr. Clowes very much for his talk which he felt sure had created much interest, and possible argument. Questions were invited.

DR. ANNE HAYMAN, M.B., B.Ch., D.P.M. (Hampstead Child-Therapy Clinic): I am wondering how much the need to limit the features which one has to see is mainly a matter of cost, or whether this is an aid. Ordinarily, people are constantly the victims of multiple receptions and the average person has the capacity to block off some conceptions and to select. I wonder whether this would be very much more difficult in the case of the blind.

DR. CLOWES: May I address myself tangentially to a question which you began to ask, the question of cost. These robots are absolutely of no technological interest to anyone as technology. They cost the earth. Attempts to get less mean that you are trying to build some rather crude knowledge into the front of your picture. The idea that you have horizontal dots or lines is just a notion, but the important thing that we are learning in the robot equipment is that you can never afford to freeze in knowledge like that because you find that the world never provides the data you want in the forms appropriate to the freezing of the protoplasm you have there. A blind man is an incredibly skilful individual just because he is individual. Can we not somehow enlist all that intelligent function that is still there? That runs counter to the idea that we should build in at cost all sorts of fragmentary knowledge. That, I am afraid, does not answer the question you asked, but it gets us back to the problem.

MR. R. DUFTON: The opticon presupposes that the reader understands the code or the sign that is being viewed. Whether that is a mathematical or an arithmetical sign does not matter, but there is the question of letter learning and all other things.

DR. CLOWES: The reader, at the earliest possible stage, must guess what the message is about and what kind of sense is being conveyed, and not think of it as marks to be detected. There is a beautiful passage in Alfred Leonard's monograph when he talks about real sense and environment. He talks of the syntax of streets and of how one has to think how streets are organised and that you do not have stationary vehicles parked on the pavement. This is not novel. I am not saying anything new here. One has to make the imaginative person understand what it is all about and on that basis to use the device to form an hypothesis. The message we have tends to show that we must look at mobility training and we must produce some new sets of knowledge to utilise the heterarchical devices.

Mr. Lloyds thanked Dr. Clowes and said: That is the final paper in this Sensory Devices Section. I think that all the papers have shown that a very great deal is happening in this country in research into the fields of mobility and reading and I think it very gratifying that there is this forward-looking programme in many places. Unfortunately, all this research takes a long time until something comes up and is found to be of help and can be put to use. Evaluation has been mentioned, a problem which has caused us concern here and in many other countries. America is, of course, concerned not only from a purely technical or mechanical point of view, but rather with how one should assess the usefulness of a device and its acceptability to a blind person. It is still an open question how best to go about that. Fortunately some strides forward have been made trying to get better evaluation of some devices which have been invented.

Mr. Wall said that the thanks of the meeting were due to Mr. Lloyds for having taken the chair. This was greeted by applause. An interval for dinner then intervened.

PART II — AIDS AND APPLIANCES

In announcing the second session, MR. JOHN A. WALL said: Ladies and gentlemen, the Chairman for this session is Mr. John Colligan, Director-General of the R.N.I.B. I think he is very well known to all of you and hardly needs any introduction from me. I ask him to take the chair and to introduce the speakers.

MR. JOHN C. COLLIGAN, C.B.E.: All that it is necessary for me to say from the chair is that we are all very grateful for the opportunity to get together and to discuss these vital questions of research.

Mr. Wall introduced me as Director-General of The Royal National Institute for the Blind, but it is in the guise of an officer of the World Council for the Blind that I appear before you tonight. The World Council, for some years now, has had a technical sub-committee for general technological problems of research into blindness internationally. I have been a member of that sub-committee since its inception and Chairman of it for a number of years, and both my colleagues who are to give papers tonight are members. It is well, I think, to remind an audience of this kind that there is in existence — arising out of a conference convened by the American Council for the Blind in 1962 — an International Research Information Service. This is based on the international headquarters in New York to give researchers into any problem of blindness access to what is going on in various aspects throughout the world so that there will not be duplication of time and energy.

The American Foundation for the Blind celebrated its 50th anniversary last October with an international conference at which some of the leading researchers in the United States were present. The theme was Science and Blindness: Retrospective and Prospective. This was an occasion on which the award of the Megal Medal for research was awarded to someone whose name will be familiar to everyone in this room, Dr. Jerome Wiesner. Dr. Wiesner called on scientists and technologists to make a large-scale effort to develop sensory aids to help the blind, the deaf and the deaf-blind. He said that now was "a propitious time for such an undertaking. At this moment the basic understandings and the sophisticated technologies needed to take major steps forward in sensory learning aids for the blind, the deaf and the deaf-blind converge with a Presidential search for challenging problems to engage the under-employed research and development industry of the nation." That, I think is as true here as it is in the United States of America.

One thing that I should like to say before I introduce the speakers is that it seems to me from the programme for this Conference that we in the United Kingdom have no need whatsoever to reproach ourselves with lack of forward-looking research work. Ours will stand comparison with anything that goes on anywhere in the world.

Our speakers tonight, who are the technical officers of the Royal National Institute for the Blind and St. Dunstan's, come from a precisely similar background. Both have had careers in industry and have brought their influence to bear on that section of aids and appliances which will be of direct benefit to blind people.

I will call on my colleague, Cedric Garland to speak of the work of the R.N.I.B. concerning research on aids and appliances.

AIDS AND APPLIANCES

by Mr. C. W. Garland, C.Eng., M.I.Mech.E., Technical Officer,
Royal National Institute for the Blind.

It is difficult to know just where to begin discussing this very extensive subject of aids and appliances for the blind, and at the same time do justice to the many ingenious devices that have been developed over the years.

One can perhaps state the need for aids in three general categories of person. Firstly for the younger age group, aids for education are of prime concern. Secondly for those of working age, emphasis must be placed on aids for employment coupled with the need for good mobility in getting to and from that employment. Thirdly, by far the greatest proportion of blind people are the elderly for whom aids are required largely for purposes of entertainment; also for those who lose their sight late in life, for rehabilitation. Such generalisation can, however, over-simplify the situation and within each of these three categories one finds both the general purpose aid for which there is a fairly large demand like a braille writing machine, or a walking stick, as well as the more limited quantity special purpose aid like an Electronic Timer to enable Blind Physiotherapists to control treatment times.

Judging from the numerous ideas for devices that we receive, it is by no means uncommon for sighted people to make the mistake of inventing aids for the blind which solve problems that do not really exist for them. The development of aids must be carried out in close consultation with the blind in order that a need should be clearly defined and any resulting apparatus field tested by blind people themselves to ensure that the objectives are achieved. If blind people are to be fully integrated into a sighted environment, they are much better served by not being encumbered by numerous special devices, and the ingenuity of invention in this instance lies in moulding modern technological progress to the advantage of the blind whilst maintaining a subtle balance between the function of an aid and its use in a sighted environment in a way that does not draw unnecessary attention to the blind user.

For the moment I propose to confine my comments to the last five years or so and refer briefly to some of the aids with which the R.N.I.B. has been concerned.

For educational purposes we have developed an electronic thermometer for use in school science experiments, having a range of –5° to +105°C. measuring to within an accuracy of 1% of full scale, the thermometer utilises a thermister sensing element built into a probe forming one leg of a Wheatstone bridge which in circuit generates an audible tone in the out of balance condition and a null, or point of silence, at the temperature concerned, which is read from a circular braille scale. There is also a digital counter giving a braille readout to an accuracy of one-tenth of a second for use in mathematics or physics experiments and we have also adapted two chemical balances, one being a two pan balance with weights and a braille readout to the nearest 1/10 gram, the other being a single pan digital balance with braille readout to an accuracy of 1/100 gram. Both balances give a high or low audible indication of the out of balance condition with a null at the point of balance.

The R.N.I.B. Sound Beacon is a battery operated device providing a variable source of sound for which there has proved to be many applications, it has been used to indicate the position of the jack in the game of bowls and the target for javelin throwing and straight running races in schools, also for general location of say tools on a bench or in the garden. Similarly the Audible Photoconductive Light Probe, which converts light intensity into sound frequency, has many applications. It was originally developed for use on the optical bench to enable a student to measure the focal length of a lens, but it is used also for detecting the point of illumination on a light spot galvanometer, or the height of the mercury column in a barometer as well as for everyday uses such as detecting the level of milk in a baby's bottle, the level of tea in a cup or merely to establish whether the lights are on in a room.

I think most blind housewives will now be using the Rain Warning Device which was introduced a few years ago, this battery operated aid when placed in the garden emits a loud continuous sound when the first drop of rain falls on a sensing grid, enabling the washing to be brought in in good time.

Within the next few months a 12 inch plastic Geographical Globe will be introduced having the land areas surface textured and in highly contrasting colour to the smooth blue sea area, the colour being, of course, for the benefit of the partially sighted. This Globe will be produced by the rotational moulding process and as a result will be quite inexpensive so that every blind child could have one.

For entertainment, the R.N.I.B. markets a range of games designed to be played by touch, braille embossed playing cards and injection moulded raised dot Dominoes in particular are very popular. One new device which became available last year is a Crossword Puzzle Set which is the most compact puzzle of this sort available. Opening like a book and of about the same size, it comprises a 15 x 15 nest of shallow recesses into which small cubes can be pressed, each cube being adjustable to form any braille character.

Small cylindrical pieces are provided to enable the pattern of blanks to be set out as instructed in braille books of puzzles which are published from time to time.

We also anticipate introducing, possibly this year, a mains operated Television Audio Receiver the size of a small portable radio and weighing about 8½ lbs. Blind people are particularly interested in listening to television sound and this receiver, in addition to having a 5 inch internal loudspeaker giving up to 1 watt output, will have output sockets for earphones and for a tape recorder or an external amplifier system. Prototypes of this receiver are now on trial and if the outcome is satisfactory, production could be initiated in the very near future.

The British Diabetic Association recently drew our attention to the need for a syringe which would enable blind diabetics to mix variable doses of different strengths of insulin. The resulting design is simple and each graduation on a 2 c.c. syringe is indicated by a positive click which can be both felt and heard while insulin is being drawn into the syringe, the process of injection however is smooth and uninterrupted. Two dozen prototypes of this design were put on field trial by the B.D.A. and initial results are most promising.

Just going into production is a new injection moulded propathene medicine dispenser which will automatically dispense the standard 5 ml. medicine dose. The device is in principle a hollow turncock with a bore of 5 c.c. volume. An integral screw cap permits attachment of the dispenser to standard metric 200, 300 and 500 ml. medicine bottles and on inverting the bottle and rotating the cock, a 5 ml. dose will be dispensed into a small plastic drinking cup attached to the dispenser. Although designed specifically for the blind it is felt that this aid may well have wider application among sighted people, particularly the elderly who may have difficulty in using the 5 ml. plastic spoon issued by chemists.

It is particularly difficult to devise aids which will be of real benefit to the totally Deaf-Blind and only two items have come into being in recent times. One is an Electric Alarm Clock with bold embossed dial and robust external minute and hour hands, the clock is connected by an extension lead to a powerful vibrator which, when placed under the mattress, has proved a most effective early morning alarm. The second item, known as the Deaf-Blind Communication and Doorbell Device, is basically an induction system necessitating the wiring of one's home with one or more loops of wire connected to a transmitter. An oscillating magnetic field is generated within the area of the loops whenever the bell push is pressed and a pocket receiver carried by the deaf-blind resident causes a small transducer, worn on the finger as a ring or on the wrist like a watch, to begin to vibrate, informing the occupant that a caller is at his home. Some deaf-blind users have arranged for a simple code to be used by regular callers in order to identify their visitor. This installation is now in operation in some 200 residences throughout Great Britain, the cost being borne by Local Welfare

Authorities and the Department of Health and Social Security. The field of total deaf-blindness is wide open for research, particularly into problems of communication.

Well within the subject of aids is the facility available to blind people to have commercially produced domestic equipment adapted for touch reading. At the R.N.I.B. we have an engineering workshop carrying out the braille adaptation of controls for Cookers, Kitchen Scales, Electric Irons, Automatic Time Switches and Central Heating Controllers. Many thousands of these controls are adapted each year and this service is clearly of value and much in demand.

The Light Engineering Industry has provided a source of employment for the blind for many years and a range of measuring devices such as braille reading Micrometer Calipers, Micrometer Depth and Bevel Gauges, Vernier Calipers and Rules for simple measurement, have enabled blind people to be engaged as machine tool operatives and in inspection. With the current level of unemployment in industry coupled with the introduction of automation, especially machine tool control, the pattern of employment of the blind in industry will undoubtedly change and new instruments to accommodate the rising standards of precision and quality control must be developed. In anticipation of such radical change, the Department of Employment, St. Dunstan's and the R.N.I.B. recently sponsored an investigation by professional staff of the Production Engineering Research Association to study the needs and abilities of blind people operating machines and processes, and to identify new areas of employment in modern industry. This fact-finding study is now complete and P.E.R.A. have been authorised by the Department of Employment to proceed with a number of projects involving practical trials with blind people, to establish the feasibility of their operating numerically controlled machines, using instrumentation giving audible or tactile indication of workpiece positioning or of workpiece concentricity in lathe work. Similar trials are also to be undertaken with blind people in the field of industrial Inspection, to establish how instrumentation can be adapted for quality control measurement involving porosity, temperature, pressure, specimen analysis and non-destructive testing. If such aids could be developed it would be a great step towards enabling the blind to compete effectively with sighted operatives in modern industry.

In the field of mobility many minds have been exercised in an effort to design a collapsible version of the long cane which would satisfy the increasingly critical requirements of long cane users. The problem is largely one of designing a joint which will enable the cane to be erected or collapsed with a minimum of effort, yet be as sensitive in use, as durable, strong, rigid, and light in weight as the non-folding one-piece canes to which users have become accustomed.

Two-piece and four-piece prototype canes, designed by the R.N.I.B. and submited to a six months trial at the National Mobility

Centre, were favourably received and a more extended field trial is to be initiated as soon as a further quantity of each model can be manufactured. There is also of course the field trial of the Kay Binaural Aid which the R.N.I.B. and St. Dunstan's are funding.

Some of the really difficult problems concerned with the provision of aids are not necessarily with their design but of getting them manufactured, even what we consider to be a large quantity of any one item is always small in comparison to normal industrial levels of production, and the cost of manufacturing aids and appliances for the blind is therefore almost always high in relation to similar devices for sighted people, if one can make such a comparison. It is for this reason that the costs of articles for the blind are heavily subsidised by the R.N.I.B. in that most items are sold to individual blind people at about one third of their cost of manufacture.

The R.N.I.B. is one of the world's largest producers of aids for the blind, and along with the American Foundation for the Blind and the American Printing House for the Blind, are responsible for the greater percentage of aids currently in existence. For those interested there is every hope that the American Foundation, under the auspices of the International Research Information Service, will soon be producing an up-to-date International Catalogue which will provide a world-wide listing of aids, a brief description of each item, and the source from which further information can be obtained.

Mr. Colligan said he thought it would be convenient at this stage to inquire if there were any questions or comments which anyone would like to make on what Mr. Garland had said.

Miss A. F. Carr (London Borough of Hounslow): I should like to make just a comment. Mr. Garland has spoken about audio equipment and television sets. There is a very important point here. Many blind people who go to work cannot discuss with their friends what has been shown on the television, but in a few cases I have been able to find broken television sets which can still operate the sound of programmes. Blind persons find these useful and there is the added advantage that no licence has to be obtained.

Mr. J. F. H. Hilbourne (London School of Economics and Pol. Science): To what extent would it be possible to eliminate the cost of products by getting one country to take over production of a specific item?

Mr. Garland: I think countries are more interested in each other's work. One of our prime objectives is to avoid duplication of effort. This is why the R.N.I.B. imports so many Perkin machines; it would be just uneconomic to make them ourselves.

Mr. T. J. Parker (Nat. League of Blind): I think that you will be raising this question in Moscow this year. One of the problems is that many parts of the world, including this country and America, can produce things, but they are up against all sorts of Customs barriers and so on. Often we cannot get things for these people, although we know of the need. We talk of limited demand, but I have heard estimates of 25 million and 30 million blind people in the world. The demand is there if we could only overcome the barriers and see that the countries which can make these articles can get them out to the people who ought to be getting them.

Mr. Colligan thanked Mr. Garland and said: Our next speaker is Mr. Dufton, Director of Research at St. Dunstan's. As I think is well known to many of you, St. Dunstan's and the R.N.I.B. work very closely together in this field of technological research into aids and appliances, but whereas the R.N.I.B. has had to take a more general view of scientific development, and its research committee is called the Scientific Research Committee, St. Dunstan's has co-operated by motivating most of this research into the field of sensory devices and also into the adaptation of certain items of equipment, or indeed the manufacture of certain items of equipment, specifically for the individual case of the handicapped blind person. I think that it is on these two aspects of work that Mr. Dufton will be likely to speak to us tonight. I have very much pleasure in inviting him to come to the rostrum, and Mr. Wills of St. Dunstan's to read Mr. Dufton's paper for him.

PART I — AIDS AND ADAPTATIONS FOR THE MULTIPLE-HANDICAPPED.

PART II — SOME ASPECTS OF TECHNOLOGICAL CHANGE IN INDUSTRY.

by Mr. R. Dufton, C.Eng., M.I.Mech.E., Director of Research, St. Dunstan's.

PART I — AIDS AND ADAPTATIONS FOR THE MULTIPLE-HANDICAPPED.

St. Dunstan's, founded in the early part of the First World War, is responsible for the rehabilitation, training and lifelong aftercare of men and women blinded as a result of their service in the Armed Forces, and some 6,500 have come to us over the years.

St. Dunstan's aim has been to ensure that each of its men receives rehabilitation and training in an occupation best suited to his capabilities and desires, and the great majority have returned to civil life, equipped to earn their own living, alongside the sighted and on equal terms. Although many have now retired from active work, over 90 per cent. of the men who were blinded in the Second World War have been trained and placed in remunerative occupations.

Usually advantage can be taken of the standard range of communication aids such as the typewriter, the braille writer, the Talking Book and portable tape recorders, but there are special categories such as the handless blind and wheelchair cases where continuous research and development are needed to meet their requirements in the daily round, for the majority live with their families in their own homes.

Where wheelchairs are involved, attention is given to " one floor living " with the provision of wider doorways and threshold and loading ramps into motor vehicles. These matters are the joint concern of our Welfare, Research and Estate Departments. Our Research Engineer continually reviews the latest trends in mobile hoist design, wheelchairs for indoor and for outdoor use, and a specification has been evolved for the complete layout of bathrooms which includes, where possible, an increase in floor area. Automatic lavatories have been installed in the homes of the majority of our handless group, and also at our Training Centre and Holiday Home. Our experience in sanitary engineering has been passed on to Medical Officers of Health, Hospital Consultants and to specialised homes caring for the disabled.

Special attention is given to the needs of our handless group, most of whom carry out a range of tasks with devices and aids interchangeably fitted into the sockets of leather forearm gauntlets.

Electric razors with extended handles and with various degrees of adjustment are typical, while forks and spoons can be located and locked into position.

Our aim is to provide the maximum degree of self-help to the multiple-handicapped, and it is fortunate that the majority of the handless group have proved to be very mobile, following a range of occupations and hobbies. For example, there is a telephone switchboard operator, a travel agent, a graduate economist, a lecturer and shopkeepers, while in recreational pursuits there is a weight-lifter and several sea-fishermen, with swimming and atheletics increasing in popularity. In 1970 the National Disabled Sportsman of the Year was a member of our blind handless group.

Similar problems exist in certain other countries and we have close interchange of information with the Veterans Administration in America. A study tour has ben made of the Design Centre for the Handless in Stuttgart. A revolutionary surgical approach to the handless in West Germany, in which the grip function is restored to the extremity of the forearm, has meant that a universal type of socket can be fitted — tools and appliances so attached can be quickly locked into position and they have an increased degree of flexibility in operation.

Power-operated hands of the mio-electric type, have probably not been used by a blind person but this aspect has been discussed from time to time with a Senior Surgeon at the Queen Mary Hospital at Roehampton, who has taken a great individual interest in each member of our group, wherever they reside. This problem was also discussed during a visit to the Institute of Prosthetics Research in Moscow in 1970. Professor Popov initiated the early work in this area in the mid-1950s, and their latest model power-operated hands proved to be impressive with a well graduated "hand-shake" and some 150° of wrist rotation — about normal. Three appropriate positions for the thumb can be pre-selected to cover a range of tasks. Questioned closely about the practicability of providing a feedback facility for a blind person to monitor proximity, when wishing either to touch or grasp an object, the Chief Engineer at the Centre felt that this was not impossible, although it appeared that this aspect had not been researched.

It may be relevant to briefly consider the problem of the suitability of materials, for the construction or the covering of functional or cosmetic prostheses. In recent years an increasing range of synthetic materials with improved mechanical and physical properties has become available, but a further requirement is also that of high resistance to staining and environmental effects in everyday use.

Many solutions still lie with the Research or the Polymer Chemist to develop even more specialised synthetic materials than already exist.

PART II — SOME ASPECTS OF TECHNOLOGICAL CHANGE IN INDUSTRY.

Aids and Industrial Change.

A significant number of St. Dunstaners, after training at our Centre, have been placed in open industrial employment, that is in open competition with the sighted as machine tool operators, assemblers, or quality control and component inspectors.

Emphasis is given during training to the correct handling of precision measuring tools such as the R.N.I.B.'s range of braille micrometers and precision gauges, while a range of equipment modified to give audio tones instead of visual information, has been developed by our Research Engineer, in co-operation with equipment manufacturers. We have found it advantageous to record machine drawing data on "compact cassettes" both in machine shop and component inspection situations.

A comprehensive follow-up service is provided for those in industry. Our Industrial Superintendent, Technical Visitors and Research Engineer all co-operate closely to provide the most appropriate assistance in the form of " jigs and fixtures " to help a machinist or an assembler to maintain efficiency at a time of industrial change in the metal working industry as a whole.

In another area of employment, a computer programmer blinded on ballistic trials, has been able to continue his work by using a specially developed terminal device. A five-channel punched tape is optically read, the resulting signals driving an electro-mechanical unit to give a one-to-one embossed representation of the punched data. This is probably one of the earliest cases of computer inter-facing and, now as a professional engineer, he is in the process of being up-dated with an American device which plugs into a teletype machine. It produces Grade II Braille on paper-tape via circuits compactly housed in a container no bigger than an attache case. Operating speed is the same as the teletype, 120 w.p.m. maximum, and the facility will be mainly used to monitor programmes.

The introduction of the Mark I Talking Book, with its 6 lb. 18-track cassette, about twelve years ago, presented loading problems for our handless group, and a combined loader and inverter was developed and also adopted for blind arthritics. The problem was diminished when the 6 oz. 6-track Mark IV cassette was introduced a few years ago, but a loader and inverter have been developed to accurately align the tape with the friction wheels of the reproducer.

Reference has already been made to tape recorded information used to supplement memory in the workshop: we have also undertaken limited investigation into " compressed speech " and " speeded-up " recordings. In the former, constant frequency is maintained and a considerable effort has been made by American researchers to explore the potentialities of this approach, and to redress the adverse balance that exists between the rate at which print is normally read and the speed at which tape recorded information can be handled — a ratio of at least two-to-one to the disadvantage of the blind.

There is clearly room for much further investigation in this area with the need for information retrieval facilities, although the alphanumeric indexing, adopted by the British Talking Book Service, is a good start with a resolution of about 100 words.

A medical aid, comprising a special syringe for blind diabetics, enables a mixed dose to be loaded. There is tactual indication of the plunger position and means for locking before re-entry into a second phial. A combined plastic guide, fitting over the phial, also provides for optimum penetration to preclude the danger of air ingress with the charge.

The Effect of Industrial Change.

The coming of large jet aircraft in the 1950s caused a minor revolution in the design of machine tools necessary to produce them. Wing coverings, hitherto made from fairly thin alloy sheeting, had to be shaped from several solid alloy slabs, weighing between two and three tons each, and about 30 ft. long and 3 inches thick. Great precision is needed to fit together these shaped panels to form the smooth aerodynamic surfaces of the wings and control areas, and a new family of machine tools was developed to tackle this difficult three-dimensional shaping process. Briefly, command signals to the machine tool are provided in the form of numerical data on magnetic tape generated usually direct from the Design or Planning Office.

More conventionally sized machine tools, based on the latter principles, are destined to have an increasing effect on the practice and economics of production engineering, while at a lower level of automation, we have seen in the past few years the introduction of " conversion kits " to mechanise and to improve production efficiency by about 50%, compared with manual operation.

In this climate of industrial change a working party, sitting in the late 1960s, recommended that an investigation into employment opportunities for the blind should be undertaken, and a project, supported by the Department of Employment and Productivity, the R.N.I.B. and St. Dunstan's, is already well advanced. It is based at the Production Engineering Research Association — P.E.R.A. The implications of technical change and innovation in the machine shop, the assembly line and quality control and inspection departments, are receiving close attention.

The new family of machine tools invariably displays a good deal of visual information in the form of " digital read-out ", and adaptations on a considerable scale might be needed were a blind operator involved. On the credit side, however, there is a trend towards the de-skilling of machine operation in some areas with whole magazines of cutting tools " pre-set " to almost finished work-piece dimensions and continuously displayed information about size, as machining proceeds.

In the absence of a clear definition of the man/machine communications problem, it is not possible to predict just how far voice recorded numerical information, say in an integrated display, might replace the normal visual information.

Should the development of special display elements, preferably in module form, become a reality, then machines and inspection systems varying widely in their degree of sophistication, might have coupling possibilities.

Mr. Colligan thanked Mr. Dufton for his paper and invited comment. None being forthcoming Mr. Colligan went on to say: I think that in closing this session I should emphasise that the International Research Information Service to which I referred in my opening remarks, is available to researchers in whatever field they operate. If it is in the general field of research, all that one needs to do is to address an inquiry to the International Research Information Service of the American Foundation for the Blind in New York. If it deals with the section called Prosthetic Aids — what we have been talking about tonight — the inquiry can be addressed to the International Research Information Service at the headquarters of the Royal National Institute for the Blind, in Great Portland Street, London. I think it might be useful to those of you who are engaged in the wider field and bringing the advantages of a university background into these problems which affect the lives of the blind, to know where you can go for information on comparable research.

We have heard a great deal this evening about what is going on in the wider field and perhaps not so much in the narrower but none the less important field. These combined efforts can do much for the benefit of the blind of this country. We thank the speakers for their papers and the audience for their attention.

Mr. Wall said: I am sure that we would all like to thank Mr. Colligan for taking the chair, and especially for what he has told us about international research (*applause*). This concluded the programme for the first day.

PART III — READING

TUESDAY, 4TH JANUARY.

THE CHAIRMAN (Mr. John A. Wall, M.A. (Oxon.)) opened the proceedings on the second day of the Conference and said: I do not think that Professor Uttley needs any introduction from me. He himself was good enough to give us a paper yesterday afternoon, which we all found extremely interesting. I now ask him to take the chair and to look after this morning's session.

READING

PROFESSOR A. M. UTTLEY (in the chair): This morning we have two speakers from universities and one from the R.N.I.B. First, we have Mr. M. J. Tobin, head of the Research Centre for the Education of the Visually Handicapped, University of Birmingham. It is interesting to see that we have a variety of papers this morning, some dealing with work for the partially sighted and others with tactile aids. I now ask Mr. Tobin to speak to us about the work going on at the Birmingham Research Centre.

CURRENT WORK IN THE BIRMINGHAM RESEARCH CENTRE

by Mr. M. J. TOBIN, B.A., Research Centre for the Education of the Visually Handicapped, University of Birmingham.

Although the title of this session is "Reading", my own brief is to outline as much as possible of all the work currently being undertaken at the Birmingham Centre. In the time available, however, it will not be possible to go into any very great detail, and certain "servicing" functions that are also performed by the Centre will have to be omitted altogether. As I understand the purpose of this Conference, it is intended that any omissions will be made good in the informal discussions that will inevitably take place outside the timetabled sessions.

The Centre has just finished the second year of its life, a life that under present financing arrangements is due to last four years, the funding coming from the Royal National Institute for the Blind and Department of Education and Science. Some eight projects, some more research oriented, some of a more developmental nature, have been started. One investigation, which is being carried out by Mrs. Norma Norris is designed to enable us to obtain some understanding of the aims and methods of teachers who are responsible for teaching English to blind children. It is hoped that this study will provide a synoptic view of this broad area of teaching and learning so that more specific projects can be undertaken, either to tackle particular deficits by the provision of structured or packaged teaching materials or to probe more deeply into the language development of blind children. Project No. 2 is a purely materials and curriculum development exercise, aimed at bringing together what is known about the teaching of science at the primary school level and at the level of those secondary school pupils who are not following G.C.E. or C.S.E. science syllabuses. Teaching science to blind pupils has its own special problems, in terms both of what one should be striving to achieve and in how to go about implementing one's aims. Mr. Oscar Myers, who is in charge of this scheme, has as one of his main objectives the validation of work schemes and laboratory exercises that can be used by non-specialist teachers — non-specialist in the sense of not having taken a teacher-training course in which science teaching was a principal subject.

Another project being carried out by Mr. Myers is concerned with investigating the work and living conditions of former pupils of Condover Hall School for multi-handicapped blind children. As most of you know, Mr. Myers was the first headmaster of Condover Hall School and through this investigation he will be able to feed back into the school information about former pupils that should be of value in determining current aims and curricula. It is rare for this kind of feedback system to operate in an educational organisation, and yet it is surely self-evident that the education of the multi-handicapped should be influenced by a knowledge of the job, social, and personal conditions of former pupils. There is always the danger with the severely handicapped that aims and objectives will be seen solely in the light of what seems currently feasible or practicable with a given child. Precedent and practibility are good guide-lines but they need to be supplemented with an awareness of long-term goals and with some idea of whether specific aims and practices are of value to the individual when he or she is confronted with the realities of a world outside the supportive structure of the school. We hope that the survey will be of help in exactly this way.

Our fourth project has been centred at Lea Hospital in the Experimental Unit for the Education of Deaf/Blind and other additionally handicapped blind children. This Unit, which is the brain-child of Dr. Simon, has some 30 children, and Miss Rose Hill and I have been carrying out a series of observational and other studies, covering activities such as play, aggression, exploratory behaviour, vocalization, mannerisms, and attention. With the growing pressure from parents and others, it seems likely that more extensive provision will have to be made for the care and education of children suffering from those multiple handicaps, of which blindness is one of the most apparent — but not necessarily the most troublesome. Methods of assessment and the setting of appropriate educational goals will have to be worked out; the work we have been doing at Lea may help to identify the kinds of tools useful to the teachers and their assistants who will be needed to man units such as that at Lea Hospital.

Project No. 5 has been a small-scale pilot study to explore the usefulness of the visual enhancement programme that has been devised by Dr. Barraga in the United States. The Barraga teaching materials and procedures are designed to improve visual functioning in children registered as blind but possessing residual vision in excess of light perception. Our pilot study has been sufficiently encouraging to suggest that significant gains in visual efficiency can be obtained following a series of lessons in which the child is systematically trained to use his sight. In view of the large proportion of children in our schools for the blind who would seem to have potentially useful vision, it may be that this particular project will have the most far-reaching consequences, effecting a change in the curriculum comparable to that brought about by the introduction of systematic training in mobility and independence skills.

Another project in which I am very much personally involved is the investigation of the course of cognitive growth in the blind and partially sighted child. The work of Gomulicki a few years ago on the development of non-visual perceptual skills in the blind suggested a " lag " as compared with the sighted, which is eventually made good by around the beginning of adolescence. My present work, which is largely — but not completely — set within a Piagetian conceptual framework, seems to indicate that there is also a " lag " in the growth of such cognitive capacities as " conservation of substance ". That is, on average the visually handicapped child is about two years behind his sighted peer in his realisation that a quantity, such as a piece of plasticine, remains unchanged when various deformations are made in its shape. This capacity is, of course, essential for real understanding of a whole range of mathematical, scientific, and other operations and concepts. The present investigation is one of a series to be carried out over the next few years. Apart from its intrinsic interest, the investigation of the intellectual development of the visually handicapped child is important because of its clear implications for the what, the when, and the how to teach. In other words, curricula, syllabuses, and teaching methods are all likely to benefit in the long run from a fuller, more detailed understanding of the course of growth of mental functioning.

Project 7 is an instance of the kind of " servicing " rôle that the Centre is called upon to play. A sub-committee of the College of Teachers of the Blind is preparing a new series of braille reading primers for use with the 5-8 year old blind child who is learning to read and write braille. The Centre has contributed to this by producing word-frequency lists based upon the spoken and written vocabulary of some 132 blind children within the specified age-range. In absolute terms, this sample seems small, but in relation to the population from which it is drawn it is a very large proportion, larger in fact than any sample from which word-lists for the sighted have been compiled. While such word-lists have come in for much criticism as vocabulary sources for the teaching of reading to the sighted, the nature of the braille code and the demands it makes upon the learner indicate that the use of a controlled vocabulary is vital in the initial stages of braille learning.

The last project I wish to refer to in this formal session is also somewhat more closely tied to the theme of this morning's session since it too was concerned with braille reading. In brief, its two-fold aim was to devise a self-instructional package to enable newly-blinded adults and adolescents to teach themselves braille and to uncover something of the interlocking structure of the teaching and psychological variables associated with success in the learning of braille. In the experimental phase, expanded cell braille versus standard cell, and contracted versus uncontracted braille were compared as means of starting the learning of the code. In the correlational part of the study, the factors being examined were tactual discrimination ability, age, sex, degree of residual vision, intelligence, short-term memory capacity, and a range of personality variables. In addition, attitudes towards braille and towards the subject's experience of learning braille were measured. To over-simplify the results rather grossly in the interests of brevity, it was found that the best results were obtained from a combination of expanded cell and contracted braille. Characteristics within the learner that were found to be associated with average superior performance on braille reading were high tactual discrimination ability, intelligence, sex (being female), and some personality traits that are related to introversion.

I trust that in this necessarily highly condensed account of the investigations we have been engaged upon some idea of the scope of our interests has been conveyed. Further details are being made available in published articles and in stencilled monographs.

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Professor Uttley thanked Mr. Tobin and asked if there were any questions.

MR. WALL: I am personally interested in this matter of vocabulary because I lost my sight when I was 8 and was immediately sent to a blind school. I discovered that the children there used a very different vocabulary from what I knew myself. Are your interesting investigations limited to children at blind schools, or also those coming straight from home? It occurs to me that in a blind school the children cross-fertilise each other with various words.

Mr. Tobin: The spoken and written vocabularies were obtained from children actually in blind schools with ages between 5 and 8 and the topics centred around home, school and holidays. The real purpose was to find what words we should be using in the very first cube Braille books. We were not so interested in finding just how different their vocubulary was from that of sighted children, but in finding the common core of their verbal repertoire so that they would not be confronted with the additional task of trying to read words not already familiar to them. If we used a Braille contraction, we wanted to make sure that the word in which it occurred was already a stable part of their repertoire. I think it is true to say that we did not find any great differences, certainly when I compared my lists with those of Gates and others for sighted children.

Mr. G. Slaughter (Nat. League of the Blind): I should like to make a comment, not actually a question. Going back many years, when I was 14½, I went to a blind school and I found the pupils' mastery of English, written and spoken, was very good. I found that they were well up to the standard of sighted children in spoken and written English, but I also found that spelling was way behind. I concluded that that was caused by the use of Braille contractions. I do not know whether there was any other reason, but that was the conclusion to which I came.

Mr. Tobin: I suspect that you are right, in part. Learning ability is affected when they come to typewriting and have to use a fully spelled out system. Then they have problems because for some words they have used single symbols. And, of course, the blind child does not have the advantage that a sighted child has of walking along a street and seeing advertisements and so on.

As to the value accorded to Braille contractions, most of them occur so infrequently as not to save a lot of space, and having to learn them increases the cognative load, which is enormous anyway.

Mr. T. J. Parker (Nat. League of the Blind): I should like to make a comment on that last point because I use Braille extensively. It is a tool and all of us who take notes at meetings probably find that other blind persons can use it. I hope that no expert will come up with the idea that we should abolish contracted Braille. It might affect spelling, but when we read we want to read for pleasure and switching to uncontracted Braille or some foreign kind of Braille that we have from time to time slows down reading. So I hope that none of you experts will get the idea that we should do away with contracted Braille.

Mr. Tobin: You find it difficult because as an expert Braillist you have to go back to another system, but the work of Nolan in America has shown that contracting tends to slow down identification of less familiar words.

Mr. Parker: No. I can remember.

Mr. Tobin: The work I am referring to is a very serious study carried out on a large number of Braille readers. If you are an expert Braillist, you see some of the problems, but the whole business of longer recognition thresholds required for whole words for which there are contractions seems to have militated against the success of some learners. I am not saying that there should not be contractions, but one wonders whether perhaps the right combinations of letters have been contracted. When it comes to very familiar whole-word contractions, it is very valuable, but when we come to polysyllabic contractions, the time taken to cover them and then to break them up, ought to make us think of the implications of the work of Nolan.

Mr. Parker: May I make this final comment? I am a little disturbed about what you are thinking. I can remember that before I lost my sight I could take up a book and virtually take in the whole page at once, but when reading Braille the most that I can take in is what my left hand index finger and my right hand index finger can pick up on a line. If I can cover a word with the tip of a finger in one movement instead of having to move across the whole word, that increases my speed of reading.

You have to accept that we cover a very limited area in reading Braille with the movement of a finger as opposed to someone seeing a page and taking in whole paragraphs, if not the whole page. The more that we can condense into a limited space, the easier it is and the more fluent one becomes in reading, so frankly, I think you experts ought to take another look at this and not attempt to foist it on blind people.

Mr. Wall: May I make two points? Am I not right in saying that no one has tested whether blind children spell worse than sighted children?

Mr. Tobin: This is a very subjective impression.

Mr. Wall: On the matter of contractions, although I entirely agree with what Mr. Parker has said as a personal Braille reader, I can follow the point about the difficulty of understanding contractions. But it would be true to say that there is a distinction between reading newspaper material and pleasure reading and reading technical material where you could legitimately have contractions because people using that material — I am thinking personally of legal stuff because we have all sorts of special contractions for lawyers and obviously such things as physiotherapy — where there must be contractions for the reading public because they are technically qualified.

Mr. Tobin: In referring to Nolan's work, I was drawing attention to the fact that the contracted system has considerable disadvantages for a large number of Braille readers, but that does not mean that I think we should abolish the system. When we look at these opinions, we find that the results have been based on data gathered from large numbers of Braille readers.

Dr. H. Heath: If one is to judge how quickly a person can recognise a word, whether in contracted or uncontracted Braille, that person should be equally good at reading both forms. I find it much harder to read uncontracted Braille than contracted Braille, in fact, I am much slower at Grade I Braille because it is so strange. I cannot find how Nolan arrived at this conclusion.

Mr. Tobin: I think that the best thing for me to do is to give the references privately to those who wish to follow this matter up.

Professor Uttley: I think it important that this has happened. Here is a topic of great interest to people with entirely different points of view. I hope that this discussion will go on in the laboratories.

Mr. W. Thornton: On an entirely different subject, I wonder if Mr. Tobin and his group have considered the teaching of longhand writing in schools. It disturbs me to come across a young man who writes Braille extremely well but cannot write his own name in longhand and has not the slightest idea of what longhand capitals mean.

Mr. Wall: The R.N.I.B. will provide one with a signature which is very good. I became blind after I had learned to write, but I know the R.N.I.B. has produced a very clever system to get over this difficulty.

Professor Uttley then brought the discussion to a close as the session was over-running schedule, and thanked Mr. Tobin for his extremely interesting address (*applause*).

Yesterday, Mr. Garland spoke on the general services of the R.N.I.B. Now he is to speak on methods of production of embossed material.

METHODS OF PRODUCING EMBOSSED MATERIAL

by Mr. C. W. Garland, C. Eng., M.I.Mech.E., Technical Officer,
Royal National Institute for the Blind.

When I first joined the R.N.I.B. I felt that nothing could be simpler than to emboss dots into paper, and even to create raised diagrams seemed to present no particularly difficult problem, but, just as most things seem simple to the uninitiated, the more deeply one becomes involved the more one appreciates the intricacies of providing materials for reading by touch.

By no means of least importance is the basic material to be embossed, mainly paper. It must be a material of long high tensile fibre to accommodate stretching into raised characters, after which it must be durable enought to retain its shape to withstand often repeated reading without deterioration of the quality of embossing. The advent of plastic sheeting initially appeared to offer a suitable alternative to paper but, although now widely used for small quantity braille and diagram reproduction, it is not really liked by blind people because it is non-absorbent and tends to make one's fingers sore after long periods of use, particularly in warmer weather when one's hands are likely to be damp. Plastic is used only because it is easier to process than paper where very small numbers of copies are required. Where exceptional durability is required, such as for general-purpose geographical maps in schools, there appears to be no practical substitute for plastic, but from the blind user's point of view there is no material more preferable for embossed braille and diagrams than paper, and future research into the creation of embossed matter for the blind would do well to take this into account.

The simplest braille writing device available is the ordinary pocket frame which enables the blind user to make braille notes in paper, dot by dot, with a pointed hand tool called a style. For use at home, school, or at work there are a number of six-key machines which permit the embossing of braille character by character into paper sheet or paper tape. From this single-copy requirement one then progresses to multiple-copy work: the number of copies and the purpose for which those copies are required largely dictate the method by which they are produced, but they almost invariably involve the use of power-operated or power-assisted machinery. The Thermoform method of vacuum-forming thin plastic sheet reproductions of an embossed paper master has proved a useful tool for use in schools and enables limited copies of sheet braille or diagrams to be reproduced on site. For larger quantity production, however, one moves to the use of manually-operated power embossing machines which create metal master plates for subsequent mounting on power-operated platen presses to emboss high quality manilla paper copies for book and magazine production. In parallel with these machines are those perforating metal stencils which are used in the solid dot braille rotary printing process, developed by the R.N.I.B., whereby plastic dots are deposited on thin paper for book and magazine production, a process which achieves durability of dot on a comparatively inexpensive paper, and at the same time reduces the bulk of the resulting publication by approximately 45% in thickness.

In addition to the above transcribing processes, all of which demand a knowledge of braille from the operators, is the application of a computer which, now installed at the R.N.I.B. and programmed with the rules of braille, automatically translates an alpha-numeric letter-for-letter keypunch input into a braille coded output in punched card form. This output is then fed to machines developed at the R.N.I.B. which automatically produce either the embossed metal master plates or metal stencils for both embossed and solid dot braille publications, demanding no knowledge of braille from most of the operating staff involved. This application of the computer to braille processing is now operational in an everyday production sense and is helping to increase the extent of braille produced by processing novels and magazines, leaving our skilled manual transcribers free to concentrate on more complex publications. Further development of the computer programmes is constantly under review and if computers come more widely into use in the printing industry it is possible that letterpress books may be transcribed automatically into braille direct from compositors' tapes. Ultimately, of course, one looks forward to the time when print recognition machines will be available to enable almost any printed publication to be converted into braille without human intervention.

Of more immediate application, however, are two devices concerned with producing braille that are perhaps worth mentioning. One is an experimental terminal for use by blind computer programmers for operation in a full duplex mode on line to a computer, giving a good quality embossed braille facility in page form as well as a simultaneous and optional letterpress printout of input to and output from the computer. This terminal, designed for telephone line connection to a distant computer, has been constructed in prototype form and is expected to be operational before long, not only for the purpose mentioned but also as a potential educational tool for teaching computer science to blind students.

The second device, at present in an early experimental stage, is a sensing machine which will scan an existing page of braille and reproduce this in single or multiple copies on paper or alternatively into embossed metal master plates or metal stencils, whichever is required to suit the production requirements of the publication concerned. Such a facility would enable the Institute to reproduce such publications as textbooks of which only one hand-transcribed copy may exist. It would also enable professional transcribers, who normally work with power-operated metal plate embossing machines, to use quieter, lightweight and less tiring desk machines embossing into paper, which would be far easier to correct than metal plates. It would also enable the work of home transcribers to be integrated into large quantity braille production without having to be re-transcribed by hand into metal.

The only other system of embossed lettering now surviving, indeed flourishing, is that invented by Dr. William Moon of Brighton in 1847. Moon lettering consists mainly of a selection of boldly embossed roman letters of simplified shape and is now being read by some 4,000 elderly people who do not have the sensitivity of touch to learn or to read braille. Moon publications are still today being processed by the R.N.I.B. by the same method as that used in 1923, when it was first embossed direct from metal type set by hand directly into a chase. Each chase is equivalent to one page of about 900 characters and can be set in about half an hour, after which the chase is mounted in a platen press for duplication of paper copies. The paper is moistened beforehand to avoid the splitting at the crest of the embossed characters due to radical disturbance of the paper fibres, and after embossing the pages are heated and dried before being bound into book or magazine form. Moon characters are embossed more than twice the height of braille dots and a considerably greater pressure, about 100 tons over the area of the chase, is required to produce a consistently high quality page. Many attempts over the years have been made to find a more modern process whereby the production of Moon could be improved. The possible use of automatic type-setting machines like the linotype, or of photosetting processes using etched plates like the monophoto system, or of the automatic redistribution of the metal type pieces after use, have all been investigated in depth but have been found either impractical, uneconomic, or for other reasons unacceptable as an alternative to the traditional process.

Although Moon has been in use for so long, an acceptable machine to enable it to be embossed in the home has never been devised. This is primarily because any machine must be simple to understand and to operate and must involve a minimum element of fatigue for the elderly blind and deaf-blind people concerned.

A third form of embossed material can perhaps be grouped under a general heading of diagrams, but under this generalised description lies a complicated requirement for many different purposes, mostly in very small quantity and mainly for educational needs. There is of course, a selection of embossing tools whereby the blind student can produce raised diagrams, in paper, foil or plastic sheet, for his requirements in, say, geometry, physics or mathematics. In addition, there are similar tools designed for the sighted teacher to produce instructional diagrams for classroom needs, sometimes using the Thermoform process for duplication of sheet plastic copies of a paper master. Diagrams for inclusion in textbooks are produced by a special machine at the R.N.I.B. which creates a master metal plate, the machine being basically an electro-magnetic punch centred over a type of pantograph which enables the plate to be embossed with a range of sizes of dot or symbol to create lines of differing dot patterns or areas of dot texture which can be differentiated by touch. These master plates are used to duplicate paper copies for attachment in bound books, but again only in small quantity, rarely exceeding about 20 copies, frequently fewer.

For the more general-purpose geographical map, where durability is required, the R.N.I.B. produces surface-textured maps, so far mainly of the continents, for which there is a demand both from schools and individuals which permits larger quantity production to be considered and enables more sophisticated vacuum-forming moulds to be constructed. These maps are designed as complementary physical and political pairs and are supplied with a braille instructional guide. They adopt a technique of representing geographical features by graduation of surface texture, achieved by engraving the fine detail into a porous metal plate and drawing heated and softened plastic sheet into intimate contact with the engraved surface, thus ensuring a faithful and repeatable reproduction of the textures and symbols. The provision of two maps of each region permits a comprehensive coverage of information without congestion of the tactual surface.

Generally speaking, the greatest amount of work involved in the preparation of an embossed diagram lies in the initial consideration and preparation of the content of that diagram. This frequently means producing a drawing from an inkprint diagram or map, removing all of the detail which would be redundant or irrelevant, and representing the essential content in a way as clearly definable as possible to the touch, utilising as many surface textures, symbols or combinations of shapes as can be clearly included without confusing the blind user. In my experience, the choice of surfaces or variation of embossing is extremely limited and is almost as difficult as trying to find a general-purpose range of discriminable colours for the partially sighted.

From this brief but not exhaustive survey of methods of producing embossed material for the blind, it will be apparent that such methods are many and varied, and although the end-product for the blind user is inevitably similar, whichever method is used, the quantity in which a publication or diagram is ultimately required will continue to dictate its method of production and will influence the development of future processes.

Professor Uttley asked if there were any questions.

MR. JOHN A. WALL: Mr. Garland referred to the durability of embossed Braille. I remember that we used to have an embossed book dated 1870. I need hardly say that it was the Bible. I wonder if any experiments have taken place to see how long embossed Braille will last?

MR. R. DUFTON: During a newspaper strike at the *Daily Mail* two years ago, someone in the library sent me an ancient piece of Braille. The first thing I read on it was: "The aviator reached Manchester and boarded the train." I think this was in 1908 or 1909, but the Braille was of very good quality.

Mr. Garland: To answer your question, Mr. Wall, perhaps a little more directly, I do not know of any research that has been directed to this subject. I know that when books are subjected to very frequent reading the pages are varnished. I believe that for an ordinary novel the life of embossed Braille is quite long.

Mr. Wall: Is there any truth in the story that interline Braille lasts longer?

Mr. Garland: I see no reason why it should.

Mr. Wall: No, I do not.

Mr. Dufton: If you are a right handed reader and " fly back along the tramline " with the second and third finger, which is the common method, you produce an abrasion. The effective friction depends very much on the speed of the user.

Dr. Heath: I want to ask whether the conclusion is always right. What method do you use for proof-reading the output of the computer?

Mr. Garland: What I have said, almost without any knowledge of Braille, has been obtained from people involved in this subject. The only knowledge is demanded of the proof-reader and we get approximately 1% of error from computer programmes.

Mr. Parker: We in this country have probably been spoiled in that we have always had a very high standard of Braille production, but why are there invariably many more errors in solid dot Braille than in Standard Braille production?

Mr. Garland: I think that in any form of publication, whether sighted matter or Braille, one has to draw the line somewhere on the amount of proof-reading given to it. The choice is between extending our available proof-reading three or four times at the expense of other Braille publications, or extending the number of publications. I do not know whether it is true that there are more errors in solid dot Braille than in Standard Braille.

Mr. Parker: That is my experience.

Mr. Wall: There seem to be two questions here; one, the actual accuracy of the solid dot, and two, that when the stencil is blocked you do not get the dot at all.

Mr. Garland: One sometimes gets difficulties with the process and it is impossible to locate all the errors that have gone through, but normally these are very quickly found.

Professor Uttley thanked Mr. Garland for his talk and introduced Mr. Gill to talk about computer production of tactile diagrams and maps.

TACTILE GRAPHICS

by Mr. J. M. Gill, B.Sc., Department of Engineering Science,
University of Warwick.

This project, which started this summer, is concerned with the design and production of tactile maps and diagrams. Most of the effort, so far, has been devoted to designing a suitable production system.

In the last fifteen years there has been continuing interest in making graphical representations available to blind people. In this country W. J. Pickles of Worcester College has investigated a considerable variety of production methods and the late Dr. Leonard was particularly interested in their application to mobility maps. The design of a meaningful tactile diagram requires considerable experience of how a blind person reads and interprets tactual graphical information. The conventional methods of production are time consuming and therefore expensive.

The system being developed is based on computer-aided design principles. The diagram is considered as a line drawing. This information is input to the computer by using a co-ordinate table. The resulting picture is displayed on a visual display unit. The diagram can be modified by using the joystick; the present system allows the operator to insert or delete lines, to move end points of lines and to change the scale. The height and type of line can be input from the keyboard. The types of line include solid, dotted, dashed and dot-dash with a maximum of ninety-five different types.

Standard symbols can also be positioned by the joystick. These may be symbols for resistor, capacitor or map markings for either geographical or mobility maps. Alpha-numeric text can be input from the keyboard; the position on the diagram is determined by the joystick. The text is automatically converted to Grade I braille which is then displayed on the screen.

When a satisfactory display is obtained, output is requested. This can include output on a digital plotter for future reference, magnetic tape or punched paper tape. In the present system the master is engraved in a sheet of Tufnol. The engraving machine is either driven direct from the computer mentioned earlier or from a smaller computer with the data on punched paper tape; the latter system being preferred for economic reasons. The master is used on a Thermoform machine to produce Brailon copies. Alternative methods for making the master are currently being studied in order to obtain better definition on the final copies.

This system of production is fast and relatively cheap. The ability to update is very useful since it means that it is possible to load an old paper tape, modify the diagram and then generate a new engraving tape. In the next year, a set of standard textures will be included. No allowance has been made for the partially-sighted reader; the simplest solution is to use a black felt pen to emphasise the outline on the Brailon copy.

The economic advantages of this system, over the other methods in current use, are particularly favourable when only a few copies are required. The copies are produced on Brailon which is extensively used in blind schools although it is not an ideal medium. The cost of materials for a master and a dozen copies is about fifty pence. The computer time for the interactive programme costs about £1·50 at commercial rates. The visual display unit could be operated remotely over a G.P.O. telephone line but the cost of the telephone call makes this prohibitively expensive in most applications.

The main drawback to the system is that it requires a person with knowledge of what is tactually meaningful to blind people with varying experience of tactile graphics. This involves more than just the use of tactually discriminable lines and textures. Schiff has demonstrated the important relationship between stimulus redundancy and recognition time. Research is needed on the variation of maximum information density for different subjects. Also further studies on stimulus redundancy are needed before trying to optimise the design of tactile diagrams.

Mr. James of The Blind Mobility Research Unit will be using the system to assist in the evaluation of mobility maps. Previous work, by both Leonard and Wiedel, has been limited by the method of production. The particular advantages of using this system are that symbols (for steps, trees, etc.) can be simply and accurately defined and that a map can be easily modified on the visual display unit.

Mr. Tobin of The Research Centre for the Education of the Visually Handicapped will be involved in investigations on defining sets of tactually discriminable lines, textures and symbols. Research has been done in this field by Heath, Culbert, Nolan and Morris in the States but they were limited by their methods of production. It is most important to do this research before trying to optimise the design of tactile maps and diagrams. The results of this part of the project will also be used to improve the design of mobility maps.

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Professor Uttley asked if there were any questions.

PROFESSOR R. J. FLETCHER (City University): Could Mr. Gill please repeat what he said about increasing the contrast in the drawing of maps for the partially sighted by the use of a felt pen?

MR. GILL: The simplest way is to take a black felt pen and run it along the outlines rather than to try to automate that part of the system.

MR. GARLAND: I rather missed the costings. Would Mr. Gill give an idea of what the production of one map for one individual would cost?

MR. GILL: The cost of materials for a dozen copies would be about 50p, but because of interactive computer time it would be £1·50. For a mobility map you would probably have to send someone round the route and pay someone for that, but on the computer it takes about five minutes. Unless the system is automatic, you allow about half an hour, and that person has to be skilled.

MR. GARLAND: One has to do this irrespective of which method is used?

MR. GILL: Yes, unless someone has already prepared the map in sketch form. If the engraving machine is sitting idle, it is quite cheap.

MR. GARLAND: Are you ignoring the basic costs of the visual display unit?

MR. GILL: That is about £1·50. That is what the university charges people outside.

MR. R. MOLLOY (City of Birmingham Polytechnic): Are there any samples of these maps?

MR. GILL: That is one in Braille.

MR. MOLLOY: Given time, with a digitizer you could come out with a system and cut this out?

Mr. Gill: It is much cheaper to work fast and make mistakes than to correct on a digitizer. When typing in Braille one sees that the Braille goes across the line and one can squash the diagram or blow it up to different sizes and that kind of thing.

Dr. A. D. Heyes (Universty of Nottingham): To what extent are you able to use existing ordnance survey maps; do they show features you are interested in?

Mr. Gill: They show trees, but in general not lamp-posts. It largely depends on what you want to put on a mobility map. Do you want to show whether a person will be walking uphill, which often is useful information? They mark post boxes and trees.

Dr. Heyes: May I pursue this? I believe that you have been in contact with the Ordnance Survey. I wonder what response you had. Are they very helpful?

Mr. Gill: Yes, they are.

Dr. J. D. Armstrong (University of Nottingham): The position of trees is not in fact marked accurately. The presence of trees is marked, but not the accurate position.

Mr. Gill: Not the whole country is covered by these maps, and things can be modified by development.

Professor Uttley: We have seen a delightful set-up for producing maps and now we are discussing what should be put on them. We want to know the cost of making these maps. May I ask a question? You said that you have to do more research before rushing into anything, but what I should like to know is whether the University of Warwick is likely to offer a facility for the whole country.

Mr. Gill: At present we are interested in research and to produce any number wanted for research.

Professor Uttley: Will you try to meet the needs of blind students at Warwick? Have you many?

Mr. Gill: We have only two at present.

Mr. W. R. K. James (City of Birmingham College of Education): I am interested in the versatility of this subject. How far can it make different types of plate, for instance, for the filled in landscape map of geographical areas? Can you put in different objects?

Mr. Gill: At present we have a very simple, crude machine, which has a single head on it. It takes about half a minute to change a head. If we find that we require to use more than one we can provide a tool for that, but we would have to work out the cost.

Mr. Thornton: This simply seems to ignore the work we do in Braille. The straight line is that of the Braille dots, which, I suggest, are a lot easier to recognise.

Mr. Wall: One of the problems is getting the initial material. There has been talk about the Ordnance Survey maps not being very good and Mr. Armstrong said that trees were not shown in the right positions. There is aerial photography. Would it not be useful to you if you were preparing a map of, say, Cambridge, to have some aerial photographs?

Mr. Gill: The Ordnance Survey surveys it by aerial photographs, so I think we would leave them to pay the cost (*laughter*).

Mr. Wall: Another thing which intrigues me is that, although you have spoken of maps and diagrams, you are primarily interested in maps of a fairly close compass. On the matter of diagrams, have you considered diagrams which would illustrate for blind people the height of buildings? As a blind person, I find it difficult to visualise a skyscraper and so on.

Mr. Gill: A few weeks ago I made a map of buildings in the university showing different heights of buildings.

Mr. Wall: In addition to looking down from above, you could do it sideways as a sort of profile?

Mr. Gill: We could.

Professor Uttley: Do I get the impression that all your technology is over and you want to call yourself a map-maker? Is this your main interest rather than technology?

Mr. Gill: The two interact.

Professor Uttley: But on the whole your technical design is complete?

Mr. Gill: On the whole, yes.

Miss Alison Shaw (Royal College of Art): What is the maximum height of line that Mr. Gill's system can achieve?

Mr. Gill: Ninety-nine thou. on the present system, but up to a quarter of an inch.

After an interval for coffee.

Professor Uttley said: We continue our morning session with a paper by Mr. James, who will speak on systems of illustration for the visually handicapped.

SYSTEMS OF ILLUSTRATION FOR THE VISUALLY HANDICAPPED: PSYCHOLOGICAL PRINCIPLES OF DESIGN AND USAGE

by Mr. W. R. K. James, D.P.L., City of Birmingham
College of Education.

Aspects of the Case for Illustration.

The nature of the contribution made by illustration to qualities of experience and the kinds of thinking by which we construct the reality of our visual environment has received little systematic exploration. Let it suffice, for the present, to recognise just two functions of illustration. Firstly, illustration may enrich and extend experiences of things not present in the immediate environment. In the second instance, the use of a pictorial illustration or symbol to " park " some complex idea or principle frees the mind for other action. It also permits relationships between complex situations to be examined and new ideas to be generated.

The use of illustration for the purpose of assigning and reinstating information develops early in a child's life as, from birth, he is exposed to a wide range of representations and illustration. The child is, in fact, provided with pre-processed models of how to perceive the world. It could be argued that they may exercise a powerful influence upon an individual's approach to the pick-up and organisation of information from the environment.

It is conceivable that the visually handicapped may derive similar advantages from an appropriately designed system of illustration.

Characteristics of Tactile Illustration.

A straightforward transposition of visual pictorial representation into tactile form clearly has little to recommend it, although there are many examples of this approach to be found in Braille books and in educational usage. Foremost among the distinguishing features of usable illustration for the visually handicapped are clarity and a lack of complexity. But, while these characteristics facilitate tactile discrimination, they also impose limitations upon the amount of information a representation may carry. The designer of tactile illustration is thus faced with the task of supporting information to be acquired tactually with information to be derived from other sources. It is in this context that the notion of a system becomes useful — that is to say, emphasis is laid upon dependence and interaction which takes place between components. A system of illustration, therefore, emphasises that the meaning of a represented form may be dependent upon a purposeful search for sensory information, reference to particular categories of experience and the support of additional verbal information. These qualities further distinguish a system of illustration for the visually handicapped from the relatively passive, receptive perceptual behaviour generally associated with illustration when used visually.

DESIGN FOR A SYSTEM OF ILLUSTRATION.

An enquiry into principles underlying the design of effective forms of representation for the visually handicapped was initiated at Birmingham University in 1958; subsequent development was pursued independently.

The terms of reference of this enquiry were to examine the feasibility of representation or illustration for the blind with respect to psychological validity and to the practical problems of production and usage.

It was recognised at the outset that a visual handicap influences both quantity and quality of information acquired from the environment. Furthermore, the perceptual processes which mediate the pick-up of sensory information and its meaningful interpretation do not develop to a relatively automatic level as in a seeing person, but remain at a comparatively primitive level. A level at which purposeful search for information, deduction of meaning and synthesis of concepts takes place consciously. It was proposed, therefore, that a system of illustration should be designed to fulful a series of objectives which were hierarchical in nature.

Firstly, illustrations were to provide a means of systematic perceptual training in the skills of procuring and organising sensory information. A second objective was to provide representations of things which fall beyond the range of normal tactual experience. The perceptual and deductive capabilities developed in these first two instances were judged to be pre-requisite to the use of illustrative material at a third level which provided a means of organising information and of establishing relationships which underlie complex ideas — such as map reading or reading a radio circuit diagram.

Factors which determined the procedure of the enquiry were largely established by the decision to define conditions of visual handicap as " totally blind from birth ". It was argued that this would be the only meaningful definition for the purposes of this enquiry. Consequently, subjects within an age range appropriate to the learning tasks were so small in number as to preclude controlled experiments for the collection of grouped data.

Evaluation of the system of illustration was necessarily an ongoing process over a period of years. Appraisal of a subject's performance with respect to learning from illustrative material was made at two levels — at a cognitive level when conceptual knowledge was evaluated as Very High to Very Low on a five point scale, and at a performance level when perceptual activity was evaluated as Very Effective to Very Ineffective. Similar rating procedures were used to determine whether perceptual and thinking skills could be sustained in new situations.

Initial experiments were carried out using illustrations in the field of Natural Science. A series of three-dimensional representations of creatures adapted to living in water was made by a latex casting process to produce realistic models sufficiently flexible for the tail, fins and body to be moved to simulate their usual functions.

Subjects were rehearsed in the categories of experience necessary to support the functional meaning of the models and their parts — they experimented with shapes moving in water. They were then taught how to procure information from the illustrations on a basis of hypothesis testing, and how to organise tactile experience in terms of other knowledge. When instruction was gradually reduced as the subjects progressed through the series of representations, it was found that once a basic functional concept was established, a fish in this case, it provided a new and higher level basis from which to make inferences about different species. With some subjects this was extended to species which were not represented.

Perceptual and deductive capabilities acquired in this series of illustrations were found to transfer to a series of realistic representations of creatures adapted to flying. This series, comprising a grasshopper, a wasp and a dragonfly was constructed from P.V.C., while the functional components such as wings were sprung to facilitate simulation of movements during flying. In a number of cases, the categories of experience necessary to endow the represented forms with meaning were sufficiently accessible as to make rehearsal of the behaviour of shapes moving in air unnecessary.

On occasions when two-dimensional representation was judged to be appropriate — a butterfly or the skeleton of a fish, little difficulty was shown to be experienced in establishing their meaning provided there was an adequate verbal link with the relevant categories of experience.

On a basis of evidence obtained from these experiments, a further series of illustrations was produced to represent such things as leaf patterns, a snow crystal, a spider's web and like objects, many of which being inaccessible or providing limited information to tactile exploration.

The foregoing discussion has been concerned with the representation of object space and it may be argued that the ability to interpret object space may well be pre-requisite to the capabilities related to interpreting environment or landscape space. From this position a series of illustrations was designed to develop the capabilities required in the organising of information relating to large structures and, ultimately, for map reading. Representations of domestic, religious and military buildings were designed to emphasise the particular shape and structure which characterised their use. The patterns of living behaviour of a Neolithic or of a twentieth century man, for example, are to some degree, reflected in the shape and contents of their dwellings; alternatively, inferences on the function and identity of a building may be drawn from knowledge of patterns of living behaviour. This duality of reasoning was recognised to be particularly appropriate to the representation of military buildings in which the functional nature of the architecture strongly reflected military techniques and strategies of the period.

An extension of these principles to larger scale space provided a systematic progression towards the representation of landscape and geographical space. Models of simple landforms were produced by latex casting while representations of more complex landscapes such as Snowdon, Malvern or Church Stretton were produced as high fidelity contoured models from 2½ inch Ordnance Survey maps by a vacuum forming process. These models provided a means of relating landscape form to patterns of water courses, the location of roads and railways with respect to contours and the like.

All of the forementioned aspects of experience with illustration may be required before such abstract representations as a map may be interpreted successfully. Some emphasis upon the idea that a map may be used to support thinking and to organise information under complex conditions may reduce the likelihood of maps being used solely as sources of unrealistic information. For example, a one inch to the mile map of Treasure Island, together with action scenes from the text may place the role of a map in a correct perspective and lay foundations for more formal map reading.

The complete series comprised maps of some thirty areas, and a terrestrial globe.

Few technical problems were encountered in the design and production of around 200 different illustrations during this feasibility study. A vacuum forming technique enabled material to be produced in quantity and supplied to any school requesting it.

Conclusions.

One of the underlying principles of this system of illustration rests on the assumption that a visual handicap exercises a continuum of effect which acts upon the processes which mediate acquired sensory information and perception. These mediating processes of selectivity, cue recognition and categorisation, and the deduction of meaning have to be sustained on increasing levels of consciousness as the severity of the visual handicap increases. The task of the illustrator is thus seen to be one of performing these mediating processes upon the situation he sets out to represent and to provide a partly processed statement in tactile form. A verbal commentary on the procedures by which an illustration was designed could well be an effective aid to the reinstatement of its meaning by the user.

Professor Uttley commented: As one who has never before had contact with such work, I feel very uplifted to see what wonderful joy and happiness it must be giving to children. I am outside this field of work, but I feel sure that others present have important questions to ask.

Mr. Wall: I should like to know if Mr. James has brought Coventry Cathedral with him?

Mr. James: I do not have it here, but I will produce the diagram for you.

Mr. W. Thornton: May I take it that Mr. James has stopped doing this work?

Mr. James: Yes. I have moved from this area of work, but I do maintain some contact. One reason for its discontinuance was that I felt I had gone beyond the original terms of reference and a rigorous appraisal of what has been done should be made before going any further.

Professor Uttley: I should like to ask something on what came up yesterday. Mr. Hilbourne asked what was being done to disseminate throughout the world the advances which were made. It seems that here is a very obvious question. Why could not all these lovely illustrations be available throughout the world? Is anything being done about this? Have other countries things they could give us?

Mr. James: During the period 1960-65 about 200 different illustrations were made to comprise this series. In schools for the blind one makes frequent contact with teachers in this country and contacts are also made with teachers from abroad. Word passes round rapidly. During this period some 4,000 items have been dispatched to 130 schools around the world.

Professor Uttley: May I ask you how reproduction is done? Is it still a craftsman's job, or have you mass-production methods?

Mr. James: The copies of illustrations are made by mass-production methods, but production of complex moulds is a craftsman's job.

Mr. Slaughter: Is is possible to reproduce architects' models? I saw one of Western Avenue, London.

Mr. James: A three-dimensional model?

Mr. Slaughter: Yes, it was of a flyover and and the model showed how the flyover went through a built-up area. It was a good model.

Mr. James: I should imagine that production of such models is feasible, but to produce such things would run into enormous expenditure.

Professor Uttley: The point was made earlier that you must have simplicity and cut out details.

Dr. Armstrong: I am interested in the question of scaling. Some of the models shown on the screen were obviously not to scale. How do you describe the areas of the model in relation to the actual scale?

Mr. James: One would expect that scale would be a problem for blind children, but it is not a problem that we have encountered. Take, for instance, the illustration of a wasp. At no stage was it necessary to say that the model was many times as large as the living creature. The children have knowledge of the wasp which is flying around and, after it is dead, they can feel its body. The illustration itself is not a primary source of information, but a means of organising information obtained from other sources.

Dr. Anne Hayman: Going back to the model and the question of the three-dimensional form, would you also use a lateral model, or would that be confusing?

Mr. James: An illustration should clearly not present its object from a viewpoint which would be confusing. When imparting information or assisting understanding, an approach is valid provided you can justify it. The decision on what to use and how to use it must lie with the intentions of the teacher, the instructor or designer who has come to terms with the need of the individual or group. I do not think that one can lay down rules that one thing is appropriate and another is not. These things must be resolved within the conditions of the particular case.

Dr. Hayman: Have you an outline model, say, of Coventry Cathedral?

Mr. James: I have not.

Dr. Hayman: That is not something you have found useful?

Mr. James: I think it could be useful for a ground floor plan, but I have not used a line drawing to show the vertical profile of the walls and roof of the building.

Mrs. A. Costley (City of Coventry): The original models of Coventry Cathedral were shown to the blind welfare organisation. They gave great satisfaction to the blind welfare organisation. They gave great satisfaction in helping people to know what the building was like. This was done with a commentary and the blind people probably then knew more about it than sighted friends who had been to the cathedral and seen what was in it. These were adults, not children.

Mr. S. J. Crews (Birmingham Midland Eye Hospital): I have been thinking of some of the modern materials which are used in making models and copies of models. The new plastics are very useful. I do not know enough about materials, but I wish to ask what materials you use. I should have thought that cardboard would be cheap for producing these articles.

Mr. James: I recognise that cardboard models are useful and a number of blind people have derived considerable pleasure from handling a cardboard model. There are many materials which can be used for clear representation of two-dimensional or three-dimensional models. However, when a large number of copies of an illustration are required, usual industrial processes and materials must be used. A vacuum formed thermo-plastic has proved to be the most suitable material.

DR. ARMSTRONG: How big was the map of the world which you showed at the end of your lecture?

MR. JAMES: It was 39 inches by 24 inches.

DR. ARMSTONG: What about production costs and so on, bearing in mind that John Gill suggested that the largest cost of producing a map was in fact the ground work? How long does it take?

MR. JAMES: Production of the master model is time consuming as it is made from aluminium. I suppose that the material costs would come to £1 or £2. The time involved would be about 20 hours in all. This kind of mould would enable production of an unlimited number of copies. Several hundred copies of the map of the world have been produced. It is in the area of rapid mould design and production that work presently going on at the University of Warwick promises to be extremely valuable. What was once a two-day task can now be resolved into something like two hours.

DR. ARMSTRONG: You used a flat projection. Do you think that a globe is better?

MR. JAMES: I think the two forms of representation of the world must support each other.

MISS A. F. CARR (London Borough of Hounslow): Can models of buildings give a better appreciation of their functions? We have a number of excellent models of our old peoples home and people are interested to feel the lay-out of them.

MR. JAMES: I think it would depend largely on the function of the building and how this was represented by the model. Often external appearances of buildings belie their internal function.

Professor Uttley ended the discussion by saying: We should thank Mr. James for his interesting talk, Many people consider that this work should be carried further.

Now Mr. Yelland is to talk about something which is straightforward and very important, clear print.

CLEAR PRINT

by Mr. M. YELLAND, B.A., A.L.A., Research Officer,
The Library Association.

In giving this paper I am speaking mainly about my Association's activities related to visual handicap. Some of you may wonder what a professional association of librarians is doing in this particular field — I hope this will become apparent as I go on.

I should like to make it clear from the start that I am talking about print, and the reading of print, for those with residual vision, the partially-sighted rather than the blind. This is not because we have any less interest in the availability of reading for the blind — it is rather a matter of provision of services. The blind are comparatively well looked after in this respect through Braille and talking book services — the partially-sighted considerably less so.

Librarians have come in contact with the reading needs of the partially-sighted in two main ways — in public libraries through trying to cater for the elderly with failing sight, and in hospital libraries through trying to cater for those with particular visual handicaps, sometimes of a temporary nature. Both types of contact have emphasised the need for the availability of reading matter in larger and clearer print than is customary, and our main effort has been directed to encouraging this kind of provision, particularly in the Ulverscroft and Austin series of large print books.

However, it was early realised that mere photographic enlargement (sometimes from bad originals) was only part of the answer, so in 1966 (aided by a grant from the Viscount Nuffield Auxiliary Fund) Miss Alison Shaw undertook on the Library Association's behalf a study into the design of print for the visually handicapped. This has been our main contribution to research in visual handicap, so its findings, and its direction pointing for future research, will form the main part of my talk.

I will not say anything about the methodology of our research (which is fully described in Miss Shaw's *Print for partial sight*) save that it related mainly to the reading needs of adults rather than children, though the needs of the two are not mutually exclusive.

The most important finding (not unexpected) was that size of type is the key factor for the partially sighted, but that continuing enlargement beyond an optimum size ceases to bring the benefit of increased legibility. Indeed over-enlargement may decrease reading efficiency, and can also be argued against on economic grounds.

Another finding was that the weight (or boldness) of type also affects legibility, particularly for glaucoma patients, those who are not really keen readers, and (to some extent) children. Differences in type face, however, seemed to have little effect on legibility except that amongst adult readers there was a marked preference expressed for sans serif faces.

There were no significant results achieved in measuring the effect of type spacing — but not all combinations of spacing were studied. Extra space between words *or* between letters and words *or* between lines had little effect on legibility, but complete simultaneous re-spacing was not studied. It should also be remembered that our tests dealt with the situation of continuous reading, and that spacing requirements may be more (or even less) critical for other reading tasks, like using a dictionary or telephone directory.

Taken together, these results indicate that, as measured by reading performance in Miss Shaw's studies, if all the best typographic features were combined there would be an improvement of the order of 35% compared with print using all the worst features combined. This I would suggest is a point of some considerable relevance to the producers and users of large-print material.

Time and funds did not permit us to investigate all the factors relating to the design of print for the partially sighted. Some of these are typographical, some are technical in other ways, some relate to the psychology of reading. The typographical factors we still think worth looking at include:

the length of lines of type

the size and arrangement of page margins

the layout of the printed page

the contrast between paper and print in terms of reflective value and colour.

We also feel that more attention needs to be given to the relative merits of various methods of reproducing printed materials. We did not study the effects of illumination on reading for the partially sighted, though we suspect it may not be the decisive factor in a visual task. However its relative importance needs looking at, in relation to different visual acuities, to different causes of defective vision, and to different kinds of visual task.

Psychological aspects of reading also require a good deal of attention. For example: to what extent does visual handicap induce a lack of interest in reading and a consequent unwillingness to read?

how far does a visually handicapped person's attitude to reading (induced by his handicap) affect his proficiency?

how far do such difficulties affect not only book reading, but also the reading of all sorts of printed matter?

can correct reading methods for everyday life be imparted to visually handicapped adolescents and adults beyond the reach of formal education?

Beyond these research problems are others of a more general nature — in education (of the general public and of the partially-sighted themselves), in public relations, and the production and making available of large print materials. All these are inter-related, and this is where my Association, and libraries in general, in collaboration with other bodies, can probably do most to help, as in this subject we are much more of an intermediary than a research organisation.

I am conscious that in this necessarily very brief paper I have not been able to do full justice to a subject which is yearly growing in complexity and importance. Two full-day conferences which my Association has helped to organise have only begun to explore some of its possibilities, so what I have been saying really amounts only to a condensed list of headings, upon some of which I hope you will comment. Two final points: 1. We are all likely to suffer visual handicap at some time in our lives. 2. Clearer print for the visually handicapped will eventually bring benefits for the normally sighted, too.

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Professor Uttley then invited questions?

Mr. Crews: I wonder whether anyone has studied the question of why large print books are not always popular. As Mr. Yelland said, it is not possible to print enormous quantities.

Mr. Yelland: There are a number of factors here. First of all, the range of books in large print is extremely small. Mr. Thorpe has introduced a number of books in the Ulverscroft series, but that number is very small when one considers that 30,000 titles are produced in Great Britain every year. Secondly, Mr. Thorpe has to run this as a paying enterprise. In the first few years the books were rather heavy to handle, particularly for frail elderly people. That might have been a cause of unpopularity.

On the other hand, I got the impression that the unpopularity to which you referred was from a visual point of view. I am not quite clear why this is. Mr. Thorpe is now using a format which is similar to that of the normal novel and it is not a question of the line being longer than in the average-sized book.

PROFESSOR UTTLEY: Is this possibly because everyone has different disabilities and to many the answer is just not large print? This may catch only a fraction of the partially-sighted and we may need something rather different.

MISS M. HENHAM-BARROW: I find that I can read some books for the partially sighted better than others, depending on the style of print. Sometimes I finish with my eyes aching terribly from reading one particular type of print rather than another.

MR. YELLAND: This points very much to the need for further research into design factors. Mr. Thorpe, for example, is using a standardised type face for his books in current production. I do not know whether partially sighted people find this too tiring to read or not, but in the absence of further research on the subject, he has to do the best he can with the books at present available. In the Stanley Library here you can see books produced by Mr. Watts in his large-print series. Books enlarged photographically from the original will differ very widely from each other and this may give rise to difficulties for some people.

PROFESSOR UTTLEY: Does anyone know whether white on black printing might appeal to a larger fraction of partially sighted people?

MR. SLAUGHTER: Speaking as a partially sighted person, I find that white print on a black page is all right, but it depends on what kind of paper is used. When you read a book you see the page as well as the print and you may be dazzled by the page.

PROFESSOR UTTLEY: That is why I suggested white on black, because the black would not dazzle you.

MR. SLAUGHTER: Yes, but I find that an advertisement in white print on black paper is not so good. Coloured printing is more difficult to read. I find black printing on a white ground is quite good. If you have a sort of glazed paper, that has an adverse effect for me because of the light which is reflected from it.

MR. DUFTON: May I make a statistical comment? You mentioned that the blind were well catered for because they could use Braille, but, as we know, only about 10,000 of the blind are of an age at which they can learn or use Braille. At the other end of the scale, allowing about 10,000 between 18 and 65, we have three-quarters of the blind population who are over 65. The incidence of blindness is about two per thousand. I think the figures you have in mind are probably twice that number. This incidence of two in a thousand applies only to the last three or four years of life.

DR. ANNE HAYMAN: I want to ask a question and I do not know whether it can be answered. It arises from the discussion on books for the partially sighted. There might be problems arising from the categorising of the partially sighted. It seems ridiculous to suggest that you can get the right print for each person.

Mr. Yelland: I think this is a very valid point. On the other hand, the production of large-print books has brought great benefit to many people and from that point of view it is worth going on because such large-print books as have been produced have been found to be of use to people with a variety of visual defects ranging from the mere general failing of the sight which all of us suffer from in later years, to more acute defects. Large print is not only for partially sighted persons, but for everyone who has difficulty with normal sized print, which on the whole is smaller than it used to be.

Professor Fletcher: This is not so much a question as rising to the bait. On the question of who needs what, a few years ago Mr. Babalola made an elementary approach to the question of black on white or white on black and I thought that there was a certain significance in his conclusion as a result. He came to the conclusion that with respect to disadvantages from corneal scattering of light, which is particularly rampant in Nigeria, black on white was better than white on black.

A Delegate: It is possible to reduce the glare from a generally white background by the Prentice slit. I think it was called a typoscope. A black, or other slit, is placed over the page and it assists the partially sighted person to " stay on the rails ".

Mr. S. Marcus (Jewish Blind Society): Administration for the partially sighted seems to be a cinderella service. We have not the same kind of administration as there is for the blind and many people do not know of the availability of large-print books. Perhaps this could be looked into.

Mr. Yelland: This is indeed a problem. Many partially sighted people gave up using libraries many years ago because then there were no books in them which they could read. It is a question of getting over to them the availability of large-print books sold in this country. Some 97% of the sales are to public libraries, but they are available for anyone to buy. How does one get over to someone who ceased to use the library years ago that there are books by which that person can benefit?

It is largely a matter of personal contact. There has been publicity on the radio about it and Mr. Thorpe, I know, is a ceaseless publicist of the work he is doing. I also know that many welfare officers in various places are doing a lot to bring these books to the attention of partially sighted people they know about, but I think that many people with very poor eyesight do not come to the notice of anyone because they think that there is no particular advantage to be gained by registering as partially-sighted. If there are members of families or friends who go regularly to libraries and know that these books are available, they could put them in the way of those persons.

Professor Uttley: In the tiny village in which I live the Women's Institute has a very good system for disseminating such knowledge and many people are told about this kind of thing.

We have overshot the time and I must apologise — though not very sincerely because a discussion which fails to stop shows that we are having a good meeting.

This concluded the morning session.

After a Luncheon interval Professor Uttley opened the afternoon session and said: Dr. Hermelin and Dr. O'Connor have been for many years concerned with psychological problems of handicapped people. Through the very important work they have done, the Medical Research Council Developmental Psychology Unit has been founded and Dr. O'Connor is its Director. They are now to present a joint paper on left handed reading of Braille.

RIGHT AND LEFT HANDED READING OF BRAILLE

Dr. Beate Hermelin and Dr. N. O'Connor of the M.R.C. Developmental Psychology Unit recently carried out two experiments on the difference between right and left handed reading of Braille, and two articles of theirs were published, one in *Nature,* Vol. 231, No. 5303, p. 470 only, on June 18th, 1971, and the other in *Neuropsychologia,* 1971, Vol. 9, pp. 431 to 435.

In the first experiment, children were found to be faster and more accurate when reading with fingers of the left hand than of the right hand. In the second study, using adults, no difference in speed was found but fewer mistakes were made when reading with the left than with the right middle finger. The findings were discussed in relation to training effects and cortical asymmetry in this session given by Dr. Beate Hermelin. A reprint of the first publication provides the material for this Report.

Acknowledgments are made to the respective printers for allowing the reprint.

(*Reprinted from* Nature, *Vol.* 231, *No.* 5303, *p.* 470 *only,*
June 18, 1971).

Right and Left Handed Reading of Braille

It is generally held that in right handed people the parieto-occipital area of the left cortical hemisphere is important for the ability to read. It is also known that the right hemisphere contributes more to non-verbal, visual and spatial functions than does the left. A demonstration of this functional asymmetry was provided by Kimura*, who showed that subjects were more accurate in reporting the number of dots presented tachistoscopically in the left than in the right visual field. Conversely, letters were identified better when they were presented to the right visual field; that is, the left hemisphere.

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* Kimura, D., *Neuropsychologia,* 4, 275 (1966).

Braille reading material for the blind consists of dots in particular spatial arrangements. The question arises, therefore, whether it will be treated as other reading material, with the dominant hemisphere playing a leading part, or whether the stimuli will also be dealt with by the right hemisphere as are spatially arranged non-verbal items. Generally, teaching methods for Braille, though not rigidly applied, seem to attempt to teach a technique in which the left index finger begins, and moves up to the middle of the line, at which point the right index finger is supposed to take over, up to the end of the line. The reasons for favouring this method are not quite clear. Motoric convenience, for example, seems an inadequate explanation, in view of normal writing practice. Writing, like Braille reading, is a manual activity, but only the preferred hand is used. When we observed the reading habits of blind children, most did, in fact, use both index fingers held close together throughout each line.

In a recent investigation, fourteen blind children, aged between 8 and 10 years, were required to read passages of Braille with either the index or centre fingers of the right or left hand. The difficulty levels of the passages were equated. The order of finger to be used, and the reading passages assigned to a particular finger, were presented according to a balanced design. Time as well as error scores were taken, and handedness was tested independently.

We found that left handed reading was significantly faster and more accurate than right handed. The effect was more marked with time ($F=12{\cdot}9$, $P=0{\cdot}001$) than with error scores ($F=3{\cdot}6$, $P=0{\cdot}025$) and more evident for centre ($P=0{\cdot}02$) than for index fingers ($P=0{\cdot}05$).

Twelve children were found to be predominantly right handed, and two seemed ambidextrous. Of these two, one read better with his right than with his left hand. The only other more efficient right handed reader was right handed. Three children, though fluent with their left hand, could not read at all with their right. These three children normally read by moving both index fingers together all along the line. Yet the left centre finger, which was not practised, was better than the right index finger.

While it could be argued that the advantage of the left over the right index finger for Braille reading may be due partly to early training and practice, this does not apply to the two centre fingers. The children stated emphatically that they normally never used these fingers for reading, yet there was a highly significant effect in favour of the left centre finger. It thus seems possible that the brain treats input such as Braille reading material as spatially arranged items, to be more efficiently analysed by the right hemisphere before or while verbal coding of the material occurs in the left.

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Received March 3, 1971.

Professor Uttley: Are there any questions on this strange finding that the right hemisphere of the brain seems to do a better job than the left?

Mr. Wall: I wonder if I might ask Mrs. Hermelin whether she has thought about the possibility of looking at other tactile questions, such as the mathematics type and movement and so forth? My suspicion from my own experience is that they are better read with the left hand than the right, but I do not know.

Dr. Hermelin: We have not done this systematically, but we have gone round asking people about it. We find, for instance, that when people read a parameter of a clock, many of them say, " Yes, we do this with the left hand." I am quite sure that one could extend this observation, but we have not done it yet. Why do you say that this is your suspicion?

Mr. Wall: The maths. Type, one tends to push them in with the right hand and to read them with the left. That is my recollection of it.

Dr. Hermelin: Thus our finding, though it might sound strange to a psychologist, does not seem strange to you?

Mr. Wall: No. The other thing I was interested in is concerned with the input of the hand to the brain. I suppose that most right handed blind people write with the right hand and the left handed write with the left hand. One thing which has interested me is an ordinary typewriter keyboard. In doing touch typing, I always assumed that one did most with the left hand, but I think the idea is that both hands should work equally. Have you any idea whether as a result of research the letters were distributed on one side or the other?

Dr. O'Connor: I do not know the answer to that one, but I think the arrangement is so that the small fingers should use the less often used letters. "Z", for instance, is to be used by the left hand little finger.

Mr. Dufton: The K, the I and the stop are right handed and they are used less often.

Dr. Hermelin: We looked, incidentally, at playing scales on a piano. There are quite a few which are played quicker with the left hand.

Dr. O'Connor: In playing the violin, the fingering is done by the left hand.

Mr. Wall: Although I am right handed, I have always unscrewed bottles with the left hand.

Dr. O'Connor: That may be because you are holding the bottle with the right hand, but of course most people might do it the other way round.

Mr. Wall: I wonder if this has something to do with the ordinary movement of the hand. For instance, in cricket you always use a bat in the same way.

Dr. Heyes: I think we may be in a position to make a very interesting observation here. The opticon, which has been described and which I have seen in California, is a device in which the right hand is used to move a television camera across a printed page and one finger of the left hand is placed in a trough.

Dr. Hermelin: Why is it devised in that way? For any good reason?

Dr. Heyes: I imagine that the right hand is used to scan the page because most people are right handed and the left hand is used to feel the sensation because it is otherwise redundant. It may be that the people who designed the opticon are aware of your observations and use the left hand specifically. It would be interesting to know whether left handed people would use the left hand equally.

Dr. Hermelin: We had a couple of people who were left handed and they were not faster at reading with the left hand. But other left handers were.

Dr. Heyes: Would it be better when a left handed person used the opticon to constrain him to use his left hand?

Dr. O'Connor: That would depend a little on Moon's results.

Professor Uttley: In the opticon the right hand is doing a very skilled motor task. I saw Miss Candy Linvill reading *The Times,* running down a column until she reached an illustration, running round this and then continuing at the correct column below it. The forefinger of the left hand feels an enlarged vibrating image of the letter, as in Moon fount.

Dr. Hermelin: One always assumes that one must read from left to right.

Professor Uttley: May I ask a question to recap on something you said before about the ability to do pattern recognition of a dot pattern in right and left fields?

Dr. Hermelin: A dot pattern is normally better recognised in the left visual field, while letters are better identified if perceived by the right visual field.

Mr. A. I. Friedmann (Royal Eye Hospital): There is a problem here. You mentioned that dots are seen better on one side than on the other and letters, which are shapes, are seen better on the other side. I cannot see how you discriminate. If you show a dot distribution, the function you are talking about must fall for the ordinary sighted person on one side.

Dr. O'Connor: In these conditions exposure times are too brief for eye movements.

Mr. Dufton: Using the opticon is not just a question of working with the right hand. I have noticed people working and operating it. One does not object to the stimulation one receives in the finger. The ball-point pen was introduced 25 years ago and a study of the handwriting with a ball-point pen may be found relevant to the sheer mechanics of reading Braille. If you write with the left hand, it is a pushing operation, whereas if you write with your right hand it is a trailing operation. For this reason, it has been found, left handed persons wear out a ball-point pen more quickly than right handed persons. I suspect that this is because there is a higher friction by the pen when it is pushed than when it is trailed. When reading Braille, if you push into the page, the reaction to the load is backed up in the finger.

Professor Uttley: I must just ask our lecturers if they want to say a final word and then I must close the discussion.

Dr. O'Connor: The biggest problem at the moment is the parallel processing independently of using the right or the left hand.

Mr. Marcus: Just one point; I read Hebrew from right to left and I find no difference in pressure when I read English from left to right.

Professor Uttley: That ends the discussion on this subject. Dr. Heath will now take the chair.

Mr. Wall: We must thank Professor Uttley for taking the chair for this session. We thank him very much (*applause*).

PART IV — OPHTHALMIC AND MEDICAL RESEARCH

OPHTHALMIC AND MEDICAL RESEARCH

Mr. John A. Wall (in the chair): I am in the chair for the first paper on this subject because it is to be presented by Dr. Heath, who will be presiding over the rest of this afternoon's session. Dr. Heath will deal with diabetic retinopathy.

THE AETIOLOGY OF DIABETIC RETINOPATHY

by Dr. Henry Heath, D.Sc., Ph.D., F.R.I.C., University College Hospital Medical School.

The results of investigations on the behaviour of platelets from diabetic patients revealed that the platelets from actively deteriorating retinopaths were more sensitive to the aggregating action of ADP than those from either normal subjects or diabetic patients without serious retinopathy. Moreover, the platelet aggregates formed did not so readily disaggregate again in vitro (Heath, H.; Brigden, W. D.; Canever, J. V.; Pollock, J.; Hunter, P. R.; Kelsey, J. and Bloom, A. 1971).

Treatment of rats with β,β'-iminodipropionitrile (IDPN) induces the development of a retinopathy similar to that which occurs in human diabetics (Heath, H. and Rutter, A. C. 1966, Forgacs, J. and Babel, J., 1968). A mild retinopathy can be caused by administering 30 mg IDPN/rat/day for 3 days and Paterson and Heath (1968) have shown that this can be greatly ameliorated by treatment of the animals with tetrahydroxyethylrutosides (25 mg/rat/day) for one week prior to and during the administration of the toxic nitrile. It has now been found that platelets from IDPN-treated rats are more sensitive to the aggregating action of ADP than those from normal rats and that treatment with the hydroxyethylrutosides restores the platelet behaviour to normal (Heath, H.; Pollock, J. and Kane, G. M. 1971).

Rat platelets can also be made more sensitive to the action of ADP by treating the animals for 8 days with 9, α–fluorocortisol (150 µg/100 g body weight/day) and sodium dihydrogenphosphate (1 m–mole/100 g body weight/day). The effect of this treatment is even more marked if the rats have been made diabetic with streptozotocin. Under these conditions, the rat platelets behave quantitatively similarly to the platelets from actively deteriorating human diabetic retinopaths. The rats also develop pathological changes in the retina consisting of the deposition of PAS positive material, the presence of microthrombi and necrosis of the cellular constituents of some capillaries. Treatment of these animals with hydroxyethylrutosides greatly reduces the sensitivity of the platelets to the action of ADP.

A hypothesis was presented that diabetic microangiopathy is caused by the transient episodic occlusion of capillaries by platelet aggregates at times of poor metabolic control. The reasons occlusions are thought to be transient are that when platelet aggregates are artificially introduced into the pig retinal vascular system they clear within 20 minutes; if permanent occlusions by platelet aggregates did occur, these would be very apparent in the retinal vascular system on histological examination, and that permanent occlusions such as those caused by glass Ballotini rapidly bring about very serious pathological changes.

The occlusions are thought to occur episodically because the retinopathy usually develops slowly with the duration of the disease and the rate of development varies markedly between patients but poor metabolic control is thought to be a contributing factor. The retinal capillaries are normally always patent but in diabetics, fluorescein angiography reveals the presence of occluded capillaries, non-perfusable with fluorescein which on subsequent examination become open again. The natural history of the development of retinopathy is thus explained if one postulates that there is a difference in the number of times at which short periods of capillary occlusions occur.

The reasons platelets are thought to be involved in the development of microthrombi are based on the facts that diabetics are known to be prone to thrombotic cardiovascular complications and that it has been reported that the platelets from patients with complications have increased adhesiveness (Hellem, A. J., 1971). Moreover, the investigations described above have shown that platelets from human retinopaths form aggregates which do not disaggregate again so readily and that in animals with experimentally induced retinopathy, the platelets are similarly more sensitive to the action of ADP and the amelioration of the retinopathy with hydroxyethylrutosides restores platelet behaviour to normal.

It is postulated that occlusions only lead to the development of the retinopathy if they occur at times of poor metabolic control when the blood sugar is greatly elevated. Under such conditions there will be a rapid focal deprivation of oxygen and a consequent local increase in the products of anaerobic glycolysis. This focal concentration of lactate could be the damaging factor to the mural cells of the capillaries.

Absolute proof of this hypothesis is not readily obtainable since it is not possible to obtain biopsies of human diabetic retinas during early stages of the development of the retinopathy. However, proof would be obtained indirectly if treatment of patients with drugs that reduced the sensitivity of platelets to aggregate was introduced and thereby retarding the development of retinopathy. Such a combination of drugs could be aspirin, for its known effect on platelet behaviour, in conjunction with the hydroxyethylrutosides, which decrease capillary permeability and fragility.

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THE CHAIRMAN: Thank you very much, Dr. Heath. We have a few moments for discussion, if anyone has any questions.

MR. S. J. CREWS (Birmingham and Midland Eye Hospital): I was glad that Dr. Heath mentioned aspirin. Would you please say what would be the appropriate dose?

DR. HEATH: It is not possible to state the appropriate dose but O'Brien has done a lot of work on aspirin in which he has shown that even one tablet has a marked effect on platelet behaviour for up to eight days. One has to be careful about the continuous administration of aspirin because of the possible effect on the stomach. If one looks at the literature and sees the work done by Field at the Jocelyn Clinic, one finds that some years ago he did some work on patients who had both rheumatoid arthritis and diabetes. These patients were found to have a low incidence of retinopathy and were probably treated with salicylates.

PROFESSOR E. S. PERKINS (Institute of Ophthalmology): Is it possible that the aspirin story is connected with the anti-prostaglandin effect? May treatment with anti-prostaglandin drugs be a good idea?

DR. HEATH: When anti-prostaglandin drugs are available, this might also be effective, but prostaglandin drugs have such a marked physiological effect that it might be difficult to administer them and aspirin would not have these problems.

THE CHAIRMAN: May I thank Dr. Heath again and ask him to take the chair for the remainder of this afternoon's session.

DR. HEATH (in the chair): Thank you. It is now my pleasure to ask Mr. Friedmann, of the Courage Laboratory of Ophthalmology at the Royal Eye Hospital, to speak.

SUMMARY — RESEARCH WORK AT THE ROYAL EYE HOSPITAL

by Mr. A. I. Friedmann, F.R.C.S., The Courage Laboratory of Ophthalmology, The Royal Eye Hospital.

Whereas there are always a number of research projects under way at the Royal Eye Hospital, a proportion of these will be similar to, or overlap those done elsewhere, so this paper will be confined to those projects that are special to, or which have always been part of the scene of the Royal Eye Hospital.

The Medical Ophthalmology Unit is concerned with the large number of generalised diseases that may affect the eye or vision, or which may be reflected in the eye.

Professor D. W. Hill is doing both Clinical and Laboratory Research into the causal mechanism interfering with the vascular supply to the eye, and is, in patients, an important cause of visual loss. Ophthalmic Genetics has always been part of the research work of the Royal Eye Hospital. This includes the children in the blind schools in England and Wales and this work is carried by the Godfrey Robinson Memorial Unit for Ophthalmic Genetics set up with generous support by the R.N.I.B.

The genetic material comes from something like 1,500 children examined in the blind school, and families who attend the Genetic Clinic at the Royal Eye Hospital.

After the families have been investigated where there is genetic eye disease, the older children are given genetic counselling (the parents also when they are available), and a project consisting of specialised investigations is being done in some of these families to attempt to find any linkages between genes responsible for normally occurring substances in the blood, such as blood groups, and genes responsible for eye damage.

Dr. Heath: The paper is now open for questions. You seem to be doing great work, Mr. Friedmann, in finding the causes of blindness. Can any member of the audience think of any other ways of doing this?

Mr. G. Slaughter (Nat. League of the Blind): I happen to know something about this matter because a member of my wife's family had a mongoloid child. There was an investigation, but all the approach was wrong. Certain tests were carried out, but they were not done in the right way and the mother was not taken into confidence. The right approach is most important. The person should be told why the research is being done; then people would be more co-operative.

MR. FRIEDMANN: I very much agree; I think patients are not told enough. Genetic counselling should become a service to people with defective sight or anything wrong with them. It could be provided partly by the State. All teachers ought to know that parents of such children can obtain this guidance. With a simple register for the whole country the information would always be available. It would be of great help to research.

DR. ANNE HAYMAN (The Hampstead Child-Therapy Clinic): I have a small proportion of retinal blastoma patients. I think some have inherited it and some have not. Would it be correct that some may be dominant and some not?

MR. FRIEDMANN: All bilateral cases are genetic and are dominant.

DR. HAYMAN: Is the cause different?

MR. FRIEDMANN: The cause is not different at all. There are new dominant mutations. If it is a new-born baby and both eyes are affected, it has a dominant mutation and will pass it on. Once the inheritance is dominant, 50% children of every affected person in it will also be affected. In a case where only one eye is affected in a new dominant mutation, nine out of ten will not pass it on, but approximately one out of ten will. At this stage we have no clue for finding which of the ten will pass it on. More work needs to be done on this.

MR. R. MOLLOY (City of Birmingham): One feels that the control depends on evaluation, but does genetic engineering mean that there is mobility?

MR. FRIEDMANN: It is quite easy to answer that question. How that will be done is totally unforeseeable. We do not know where the genes are occurring. Every person in this room has 20 or 30 pathological genes. What we are trying to do is prevention and the treatment is improving.

MR. JOHN A. WALL: I will not ask you to do it, but is it possible to give a list of various causes of blindness and to say, this is hereditary and this is not, or this sometimes is? Can this be done?

MR. FRIEDMANN: It can be done, but not with complete certainty. Very often we get phenotypes which look exactly like a genetic type, and sometimes the opposite. It is quite easy to give a list of those which are in fact genetic, but I do not think that such a list will be of any practical value. There are a number of books published on this subject.

DR. HEATH said: Thank you, Mr. Friedmann, for a most stimulating paper.

After an interval for tea, Dr. Heath, in the chair, re-opened the afternoon session and said: I ask Professor Perkins, Professor of Experimental Ophthalmology at the Institute of Ophthalmology, University of London, to tell us what is being done at his Institute.

RESEARCH WORK AT THE INSTITUTE OF OPHTHALMOLOGY AND AT MOORFIELDS

by Professor E. S. Perkins, M.D., Ph.D., F.R.C.S., Department of Experimental Ophthalmology, Institute of Ophthalmology.

In 1966 Professor Arnold Sorsby wrote, " Today more than ever the prevention of blindness calls not only for intensive attention to specialised problems, but also for equally intensive scanning of the broader issues. As for the immediate future . . . no real advances are feasible without a massive increase in our knowledge ".

I hope to tell you briefly of some increases in our knowledge which have resulted from research at the Institute of Ophthalmology and Moorfields Eye Hospital in recent years. While I shall be discussing mainly research concerned directly with blinding diseases, I must emphasise that a great deal of research at the Institute is concerned with fundamental problems relating to the structure, function and pathological reactions of the eye, on which the future of applied research into individual diseases will rely heavily.

I should also tell you that over the last three years the Research Committee has encouraged the formation of research groups comprising basic scientists and clinicians to co-ordinate and encourage research on specific problems. I believe that this has been an important development and that it ensures that the best possible use is made of our resources of skill and knowledge within the limitations of our financial support. Almost all the work on individual diseases which is described here is co-ordinated by one of these research groups, and I hope my colleagues will forgive me if I credit the results to the group rather than to individuals.

The major causes of blindness, as reported by Sorsby (1966), are shown in the Table. This Table also includes the figures for newly registered blind under the age of 65 in 1968 and there are some interesting differences in the frequency of causes of blindness. The lower incidence of cataract and glaucoma probably represents better availability of ophthalmic care. The high incidence of congenital and abiotrophic defects is particularly striking.

	On Blind Register 1962	*New Registrations* 1968 (*under* 65 *yrs. age*)
	%	%
Senile macular lesions	26·9	2·9
Senile cataract	22·6	6·3
Glaucoma	12·6	6·7
Myopic degeneration	8·4	12·0
Diabetic retinopathy	7·1	16·8
Congenital and abiotrophic defects	5·2	22·5

	On Blind Register 1962 %	*New Registrations* 1968 (*under* 65 *yrs. age*) %
Optic atrophy	4·8	**13·4**
Vascular retinopathies	3·2	**1·5**
Uveitis	2·3	**8·8**

(1) SENILE MACULAR DEGENERATION.

Until quite recently there has been no effective treatment for this common cause of severe visual disability in the elderly. Now, serial photographs of the retina after the intravenous injection of fluorescein have shown that in many cases it is possible to recognise leaking areas and new blood-vessels which are responsible for the damage to the retina. By sealing these leaking areas or destroying the new vessels by means of a laser or high intensity light source it is possible to arrest the destructive process in some cases. It is too early yet to assess the long-term results, but any favourable response is exciting in an otherwise intractable condition. We are hoping to have a new laser at Moorfields in the next few months which should be particularly valuable for this work.

(2) SENILE CATARACT.

The prevention of senile cataract can only become a practical reality when the underlying biochemical and physical changes are fully understood. Progress is being made in many laboratories throughout the world, and at the Institute we are concentrating more on the physical changes which take place during life. A new system of photographing the living lens has been developed and applied to people of all age groups. Using sophisticated measuring techniques and computer analysis of the results it is hoped to build up a complete picture of the physical changes which take place in the lens during life, and to detect the site and character of the early alterations which undoubtedly precede the development of cataract. Although this research may only be of academic interest at the moment it will provide essential information when and if the prevention of cataract by medical means becomes a possibility.

Other work in this field includes research on some complications of operations for cataract, and methods of correcting the refraction of the aphakic eye by altering the corneal curvature surgically or by the use of new types of contact lens.

(3) GLAUCOMA.

Early diagnosis is one of the most important problems in glaucoma, and although we are always trying to improve our clinical management of the disease most of the research effort is concerned with the development of diagnostic methods and a better understanding of the natural history of the disease derived from population surveys.

A new hand-held applanation tonometer has been designed and is now in commercial production, and a new type of semi-automatic visual field screener is under development in conjunction with the Department of Electrical Engineering Science of Essex University.

Experimental studies on the effect of raised intraocular pressure on the blood supply to the optic disc have been particularly interesting, and an attempt is now being made to apply the results in human subjects.

The treatment of early cases of closed-angle glaucoma by means of a laser is under trial, and some promising results have been obtained. This technique should replace conventional surgery, with its risks and the necessity for in-patient treatment, by a simple outpatient procedure.

(4) MYOPIA AND ITS COMPLICATIONS.

A special Myopia Clinic was run at the Hospital several years ago, and some useful information emerged concerning the genetics and pathology of myopia; but at present the only work in progress concerns retinal detachment. Anatomical, pathological and clinical studies are yielding new information but many problems remain to be solved. More research is certainly required into the mechanism responsible for the overgrowth of the myopic eye.

(5) DIABETIC RETINOPATHY.

Much of our knowledge of the pathology of diabetic retinopathy has stemmed from research at the Institute. In collaboration with the Royal Postgraduate Medical School the merits of different types of treatment are being investigated. The new laser mentioned previously will greatly facilitate the trial of photocoagulation and should extend the value of this method.

(6) CONGENITAL AND ABIOTROPHIC DEFECTS.

Although the cause of retrolental fibroplasia is now well recognised, as a result of research at the Institute and elsewhere, the condition has not been entirely eradicated and further research is in progress to assess safe levels of oxygen therapy in premature babies.

An intensive study of retinitis pigmentosa is in progress at the moment. Carefully controlled clinical studies have failed to show any significant abnormality in the serum levels of vitamin A and lipids in patients with the disease. A new method of measuring the bleaching of visual pigment in the human eye has however shown a reduced concentration of rhodopsin in carriers of the disease, and very low levels in patients with the disease even in its early stages.

Experiments with rats suffering from a pigmentary retinal degeneration have also given some new ideas on the cause of the condition. Although the results have at present no direct clinical application it is encouraging to feel that some new approaches to this difficult problem have been discovered.

(7) OPTIC ATROPHY.

The only research of direct relevance to optic atrophy is that related to syphilis. The possibility that this diagnosis can be missed by the conventional serological tests is being investigated in a large series of patients and controls.

(8) VASCULAR RETINOPATHIES.

Extensive experimental and clinical studies are in progress in collaboration with the Royal Postgraduate Medical School, and the changes seen in fluorescein angiography can now be closely correlated with detailed pathological abnormalities. The effects of drugs on the retinal circulation are also being studied.

(9) UVEITIS.

Clinical studies are gradually extending our knowledge of at least some aetiological factors, and recent experimental work suggests that a group of substances known as prostaglandins may be responsible for part of the inflammatory response. If this can be shown to be true in the human disease it will open up new therapeutic possibilities.

(10) OTHER CONDITIONS.

Although trachoma is rare in this country it is the largest single cause of blindness throughout the world, and a major research programme is in progress, including field work in the Middle East and elsewhere. Considerable advances have been made in isolating and typing the organism responsible for trachoma, and a clear connection has been shown between the eye disease and infections of the urogenital system. This work will be most important for future large-scale attempts to control the disease.

I have confined this brief review to research on conditions likely to lead to blindness, but a great deal of other work is in progress on eye diseases, and further details of it can be found in the Annual Reports of the Institute and Hospital.

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Dr. Heath thanked Professor Perkins for a very wide-ranging review of the study of ophthalmology carried out at the Institute and said: The paper is now open for questions. One thing you mentioned, Professor Perkins, was the question of cataract, which is so high on the list — 20% to 25%, which means that 20,000 or 30,000 people in this country are blind because of cataract. Do you think that administrative difficulties are the chief cause of their not being operated on?

PROFESSOR PERKINS: It is always difficult to understand this figure. There are many on waiting lists and people cannot be put on the register while waiting for an operation.

DR. HEATH: It has always seemed to me that this is one figure we should be able to reduce because it should be a small percentage of the 25% whose cases are inoperable. It seems that this is one aspect which should be tackled.

PROFESSOR PERKINS: I quite agree, but I would hope that if we had the figures for the last few years we would find that the position is much better. I shall try to get more figures from the Registrar-General on this.

DR. ANTOINETTE PIRIE, Ph.D. (Nuffield Laboratory of Ophthalmology, University of Oxford): On that point of a very high figure for cataract, I have always found it very odd. I wonder if it has something to do with the form of registration for blindness and when a chap has a cataract this is entered in the little box in which one writes the cause of blindness, although the ophthalmologist knows that it is no good operating on that eye because the patient has a senile degeneration of another kind. The number of cases may be inflated because of the way in which people are registered.

PROFESSOR PERKINS: Yes, I think that must be so.

MRS. M. SNOW (Macclesfield Society for the Blind): I understand that there is a danger of retinal detachment after extraction of the lens. Is it possible that in future there may be a lens transplant?

PROFESSOR PERKINS: The danger is not the removal of the lens, but interference with the retina as it takes place. Work is being done on this. It is not simply that the lens has gone.

MRS. SNOW: So it would be immediate?

PROFESSOR PERKINS: Not necessarily immediate, no.

MR. J. C. COLLIGAN (Royal National Institute for the Blind): I wonder if Professor Perkins could tell us more about retrolental fibroplasia. Can he give any indication as to what sort of trickle of retrolentals are likely in future? Some of us thought that this had been largely eliminated.

PROFESSOR PERKINS: I thought the same, but in 1968 there were 25 cases.

Dr. Heath closed the discussion by saying: I should like to thank Professor Perkins very much for a most stimulating paper.

I now call on Professor Fletcher of the Department of Ophthalmic Optics in the City University, London, to speak on visual research at the City University.

VISUAL RESEARCH AT THE CITY UNIVERSITY

by Professor R. J. Fletcher, M.Sc.Tech., F.S.M.C.(Hons.), F.B.O.A.H.D., D.Orth., D.C.L.P., Department of Ophthalmic Optics, City University, London.

The Department of Ophthalmic Optics and Visual Science involves more than twenty academic staff who combine research activities with teaching at undergraduate and postgraduate levels. Visual function is the basic interest with applications to the improvement of subnormal visual function; greater efficiency and safety among non-handicapped people are frequently involved, for instance in the improvement of eye-protection and the provision of good automobile lighting. The following headings give convenient but artificial divisions.

Basic Studies.

Anatomical research is aimed at physiological information, for example in the nerve control of the flow of tears, of the glands of the conjunctiva and of the blood-vessels within the eyeball. The work is often on monkeys and with the co-operation of Guy's and Bart's hospitals. Electron microscopy is usually involved. The muscles which rotate the eye are being subjected to both pharmacological and anatomical investigation. The consequences of ocular paralysis should be elucidated.

Visual after-images have been studied, chiefly by tracing the precise variations in colour as time elapses. Binocular matching is used and the work is being extended to subjects with poor colour vision. Scaling methods of a psychological type have been applied in several directions, notably in colour reproduction and adaptation, in subjective brightness related to visual adaptation and for estimating the changes of luminosity of coloured lights.

Age variations in refractive errors, in vision and in the visual acuity obtained with spectacles have been surveyed recently. The electroencephalograph has been combined with a device to track fast eye movements. Pattern recognition using diffraction methods has been studied by one of the physicists.

Induced Handicaps.

Several unwanted disturbances of vision can be produced by methods of treatment. Although contact lenses have immense advantages, on removal they are often found to have blurred vision; photographic measurements of the corneas of patients have been made during an investigation into the possible control of myopia by corneal pressure. Drugs prescribed for their effects on the autonomic nervous system are being used, in conjunction with a department of Bart's Hospital, to measure effects on several ocular functions.

DETECTION OF VISUAL HANDICAP.

Test methods have been a constant challenge, to which the department has responded. Charts for the assessment of vision and different types of screeners have been designed. Rapid but accurate methods are called for and general visual function as well as defects of the visual fields can be assessed. A long-term approach to the objective measurement of visual acuity falls into this section. Objective estimates of where the eye is looking under different situations often rely on the positions of reflections from the cornea. Attempts are being made to refine the methods used. A team effort has been directed at several aspects of defective colour vision, resulting in the design and proof of several new methods. These include a Tintometer test, a colorimeter, an anomoloscope and a major industrial colour vision screener with varied clinical applications. Quick analysis of type and degree of defect, including any which has been acquired, has great importance. The " handicap " produced by visual illusion is involved in a current study of the Ames window, its components and their separation.

CORRECTION OF VISUAL HANDICAP.

Low visual acuity lies between normality and blindness; devices such as magnifiers have often been used without spectacles. An attempt was recently made to establish the relationships between the corrective lens and the aid to partial sight. Imitation of poor acuity was required. Efforts have recently commenced to survey the lighting needs of such patients. Corneal contact lenses with non-spherical surfaces have suffered from the disadvantage of being difficult to check; new methods of analysis with test plates have been proved, in conjunction with production methods. Visual training and other corrective efforts are often supposed to be connected with reading disability and the connection is being investigated in a clinical manner. Depth of focus studies on the eye have indicated that accommodation fails sooner than we formerly believed; objective " retinoscopy " has been refined for the purpose. Mistakes caused by colour " blindness " can sometimes be avoided by the use of coloured lenses.

SERVICES.

The increasing difficulty to obtain specialist help to make measurements of light intensity or colour has been felt by several institutions and the Department of Ophthalmic Optics and Visual Science has been able to help in many ways. These include the provision of experimental lenses and contact lenses for humans and animals, road signal design and certain forensic tests. Patients are seen for analysis of visual function and dysfunction with unusual apparatus.

A Report of Research Work carried out in the Department is available on request to the City University, Cranwood Street, London, E.C.1.

DR. HEATH: Professor Fletcher's paper is now open for discussion.

Mr. R. Dufton (St. Dunstan's): In my laboratory 20 years ago we were using the Lovibond method to determine the more basic colours and we found that only one person got results on the Lovibond slides. Is the male worse than the female when using this system of Lovibond slides?

Professor Fletcher: I do not think that there is much difference. There is the question of whether you have normal speed and the experience to do the job, because even with senile changes and unclear vision a remarkable degree of correction seems to be built into people over the years. Colour measurement is a very important matter. We rejoice in the Lovibond system at City and are particularly interested in the use of the Lovibond colour meter for deciding to what extent colour defects fall into classes and their combinations.

Dr. Heath: I was interested to hear that the Rhodesian tobacco planter benefited by having tinted spectacles. Is it possible to correct a colour defect by using tinted glasses?

Professor Fletcher: It depends on the defect and this is a tremendously difficult field. I am sure that one of these days we shall have a super pair of specs. with moving devices in them. I say moving because I have been able to imitate other people's results in destroying colour vision effectively with alternate viewing, almost as if you were blinking rapidly. On one occasion I was able to modify colour defect by a cyclic action. I should like this to be built into a pair of specs.

Dr. Heath: We thank you, Professor, for a most interesting paper.

The next paper will be given by Dr. Antoinette Pirie, Director at the Nuffield Laboratory of Ophthalmology, Oxford. Dr. Pirie will talk particularly about cataract.

RESEARCH INTO THE CAUSES OF BLINDNESS

by Dr. ANTOINETTE PIRIE, Ph.D., Nuffield Laboratory of Ophthalmology, Oxford.

The work of the Laboratory has largely been concerned with cataract. In almost all countries where records are kept, cataract is the largest single cause of blindness in spite of the fact that removal of the cataractous lens is a safe procedure and restores sight. Thus research into the causes of lens opacity seems a reasonable project to be undertaken by one of the few laboratories in this country which is devoted to study of eye disease.

Two lines of research have been or are now proving rewarding. Twelve years ago Dr. Ruth van Heyningen, of this Laboratory, found that the lenses of diabetic animals accumulated an abnormal sugar, sorbitol. This only accumulated when the blood glucose was raised, as in diabetes. Since that time sorbitol has been shown to cause disruption of lens fibres, swelling of the lens and cataract formation in experimental animals. Sorbitol has also been found in the lens of diabetics and in the cataracts removed from diabetics, but it is not present in the cataractous or normal lenses of non-diabetics. Careful survey of patients who had had a cataract extracted showed that diabetic women between 50 and 70 were 9 times more likely and diabetic men of these ages were 5 times as likely to have a cataract extracted as non-diabetics. Thirteen per cent. of all cataracts extracted in Oxford were from diabetics. That cataract blindness in diabetics is also not a negligible problem is shown by a recent survey undertaken by the British Diabetic Society. This showed that for every three diabetics blind from retinopathy there was one blind from cataract. There may be 2,000 such blind in this country alone.

A possibility of delay or prevention of this cataract in diabetics springs from the fact that sorbitol only accumulates in the lens when the blood sugar is high. Thus control of blood sugar will present sorbitol formation and should delay or prevent lens damage. Surveys both of patients who have had cataracts extracted and of diabetics with lens opacities lend support to this view. Those least well controlled were more at risk. However in older people other factors seem to operate as well and I do not wish to oversimplify, but it is clear that risk of cataract is another inducement to keep the blood sugar within normal limits.

Another line of research in our laboratory has been a study of the proteins of the lens and the changes that take place during cataract formation. The lens is made almost entirely from proteins and these proteins are, in the normal lens of man or animals, quite freely soluble in water or saline. But a large part of the proteins of cataractous lenses remain insoluble in such solvents and this insolubility has been thought to be connected with the opacity. For example the white of an uncooked egg is translucent, almost clear, but when the proteins in it are coagulated — made insoluble — by heat, the egg white becomes opaque.

Proteins are large molecules consisting of complicated interlacing and interlocking strings of smaller molecules, the amino acids. Each protein has a characteristic size and shape under physiological conditions. Change of the environment of the protein may cause change of size and shape and physical properties. We have been investigating the changes of proteins in human cataracts, in particular the nuclear cataracts that take on a golden to brown colour.

Dr. Harding found that the first sign of change is an unfolding of the protein molecule so that it becomes more easily oxidised and disulphide bridges are formed. These can be reduced, but later — that is, as the lens opacity grows — other irreversible chemical cross links are formed, and Dr. Buckingham has found that instead of having soluble proteins of a regular size and shape the lens contains very large proteins joined together in polymers or aggregates. It is possible that these aggregates prevent passage of the rays of light through their size alone as well as scattering the light through their disordered arrangement in the lens fibre.

We think that in this way we have mapped out some of the chemical changes that take place in the proteins of nuclear cataracts. We now have to find the precise chemical nature of the links which form aggregates in the hope that this will enable us to study the possibility of prevention.

If one says, cataract is a manifestation of old age and classifies nearly all cataracts as senile, then perhaps there is little to be done. But by subdivision into separate types, by setting one's sights on delay rather than cure or even prevention, then I consider that research on cataract is worthwhile. I do therefore welcome this opportunity to express my thanks to the Royal National Institute for the Blind and the Fight for Sight Fund of America for the help that they have given to our laboratory.

Dr. Heath: Thank you, Dr. Pirie. Dr. Pirie's paper is now open to questions.

Mr. Friedmann: You mentioned change in the protein, did you use infra-red?

Dr. Pirie: We do not use infra-red. I think the active wavelengths are between 300 and 400.

Dr. Heath: May I ask a question? Diabetics tend to take a lot of sorbitol themselves. Does sorbitol enter the blood stream, and could it get into the lens?

Dr. Pirie: Sorbitol is a very odd substance. If it is outside the lens cells, it does not get in, but it does get into the liver cell, so that when sorbitol is eaten it is all mopped up and used in the liver.

Dr. Heath: So the diabetic does not do himself any harm by taking sorbitol? In America there is a great campaign about glaucoma; they are trying to prevent it by this campaign. I have always thought that diabetics should be warned of the dangers of not keeping themselves under control. I wonder if they should be told that they might go blind if they do not and that there is far less chance of getting cataract or, I should say, of retinopathy, if they keep under control.

Mr. J. F. H. Hilbourne (London School of Economics and Political Science): I want to comment on what you have said about scaring diabetics.

Dr. Heath: Scaring them and informing them at the same time.

Mr. Hilbourne: Giving them the facts of life. I think one has to look at the restrictions you place on diabetics. You have to look at whatever you tell anyone in terms of social contacts. I can remember the case of an American professor who gave certain information to an Italian woman and she owed her control over her family to that information. I think that unless one explores the social contacts, offering merely occasional advice will be of only limited value.

Dr. Heath: I will now ask Mr. Crews, of Birmingham and Midland Eye Hospital, to talk about what is going on there.

RESEARCH AT THE BIRMINGHAM AND MIDLAND EYE HOSPITAL

by Mr. S. J. Crews, F.R.C.S., Birmingham and Midland
Eye Hospital.

The Research Department was founded in 1945 in a small area of an old hospital which is to be rebuilt as part of the Queen Elizabeth Medical Complex. Work was initially centred on biochemical aspects of retinitis pigmentosa, migraine and glaucoma, also Industrial Ophthalmology, including Miners' Nystagmus. Projects now include ocular polysaccharides, therapeutic use of enzyme antagonists and drugs linked to polymers; long-term use of natural and synthetic material in detachment surgery and studies in toxic effects of drugs on the eye. Many of these are conducted with the help of different departments in the University of Birmingham.

The Eye Hospital being the chief eye centre in the city receives a large work load of patients (400-500 patients per day), including a very busy casualty department. In the past ten years there has been a steady increase in the number of special clinics where more time can be given to detailed investigation, follow-up and treatment. These include glaucoma, medical ophthalmology, retina, cornea, virus and orthoptic clinics. Recently a contact lens department has been started and an orbital/ultrasonic clinic is projected. From these special clinics and with the appointment of a Pathologist has come an increasing number of research projects: on the clinical side it is often difficult to decide when a particular investigation or treatment is truly " research ".

The " Research Department " now runs a retina clinic with a retinal investigation service. The clinic allows time for detailed examination of retinal detachments, and projects have developed on detachments resulting from intraocular foreign bodies and concussion injuries, also retinoschisis. The retinal service involves a wide variety of psychosensory and electrodiagnostic tests, in a number of which there is a close liaison with Aston University. The conditions which are being investigated include tapeto retinal dystrophies, drug retinopathies, optic neuropathies and blindness in infants.

Problems in running a small department are detailed, together with certain suggestions for their solution.

Dr. Heath said: I thank Mr. Crews very much for his talk about what is going on in Birmingham in this very important work, particularly on the testing of effective drugs, especially dealing with tb., which also affects the eyes.

Dr. Heath, announcing the next paper, said that neither Professor Brindley nor Mr. Donaldson are able to be here today, but you have heard of the very important work they do. They have sent a short abstract of their paper on development of an implantable prosthesis for blindness, which I believe Miss Henham-Barrow has kindly agreed to read for them.

Miss M. A. Henham-Barrow read the extract of the paper:—

THE WORK OF THE M.R.C. NEUROLOGICAL PROSTHESES UNIT ON THE DEVELOPMENT OF AN IMPLANTABLE PROSTHESIS FOR BLINDNESS

by Professor G. S. Brindley, M.D., M.R.C.P., S.R.A., and
Mr. P. E. K. Donaldson, M.A., M.A.I.E.E.,
M.R.C. Neurological Prostheses Unit.

The aim of this work is to enable totally blind people to read ordinary print or handwriting and to see well enough to get about. It is envisaged that a modified television camera will look at the printed page or external world and will control radio messages sent across the scalp from an array of transmitters worn in a hat to an array of receivers surgically implanted under the scalp but outside the skull. Pulses of electricity generated in the implanted receivers will be conducted by a cable running through a hole in the skull to an array of electrodes in contact with the visual areas at the occipital pole of the cerebral hemispheres.

It is important to emphasise that nothing that the Neurological Prosthesis Unit has done has yet been of any use to any blind person. An implant of the kind indicated above was put into a blind patient in 1967. Although it never worked well enough to be useful, important relevant scientific facts were discovered from its performance, and these are described in publications 1, 2 and 3. Parts of the first implant are still working (November 1971). Great progress has been made towards solving the engineering problems of an improved implant (see publications 4 and 5). It is likely that such an implant will be put into a second patient during 1972. If it is successful, then we may expect during the next five years to enable a few blind people (at most a dozen) to read ordinary print slowly and rather inconveniently. Even such limited success is far from certain; but when the second implant has been inserted and its performance thoroughly tested, the uncertainty is likely to decrease greatly. By the end of 1972 we may be able to predict whether the project will ultimately be very useful, slightly useful, or of no use.

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Dr. Heath: Would anyone like to comment on that paper? You cannot ask questions because the contributors are not here, but would anyone like to comment? I think this is a very ambitious work and one should not say anything against it at the moment. It is very ambitious because this is the only way to get a light stimulation to the brain.

Mr. T. J. Parker (Nat. League of the Blind): I was asked if I would volunteer, but I said that I see with the brain and I would rather not have this apparatus. I understand that a nursing sister from Cambridge volunteered and she has had considerable discomfort as a result. It was found that you do not get the white spots, but white flashes and if you stimulated two or three they did not appear next to each other, but separate.

Dr. Heath: Thank you very much for taking part in this comprehensive review, and thank you for being such a good audience.

Mr. Wall: I am sure we would all like to thank Dr. Heath for having chaired this session (*applause*).

This concluded the second day of the Conference.

WEDNESDAY, 5th JANUARY.

Mr. John A. Wall, M.A. (Oxon.) (Chairman of the Association) opened the morning session by inviting Dr. Robinson of the Institute of Psychiatry to take the chair and said: Some of you may know that just before Christmas he published a book, entitled *Becoming Ill.* He is now to take the chair for the rest of this session.

Dr. David A. Robinson, B.A., Ph.D. (Research Sociologist, Institute of Psychiatry): Let me begin by saying that I am here, clearly, under false pretences. I know nothing about blindness, the blind or the services which are, or are not, should be or may be provided for those with some visual sense impairment.

Although I arrived only yesterday evening, I have the impression that many people have been rather looking forward to this morning's session, probably because, after spending two days learning about aids, procedures, devices, appliances and the like, they felt that " real people " would be reintroduced this morning into the universe of discourse. Although it could be argued that sociology has no more to say about " real people " than ophthalmology, I think that I understand the point that was being made.

However, let me say that the social sciences have almost nothing to contribute to what I imagine to be the main problems of the blind person or to fundamental research into blindness and its management.

The sociologist's concern is with meaningful social behaviour, that is, with how people construct their social world and manoeuvre within it. Thus, the question of blindness and the role of the blind person is of legitimate and real interest, since being either partly or wholly cut off from one major source of data, one set of cues about the social and physical world in which he lives has clear implications for the blind person's construction of social reality. The kind of question which the sociologist will be likely to pose is not, what made this person go blind and how he can be aided, but rather, how does going blind or being blind affect the way in which this person makes sense of the world about him and what implications does this have for the whole complex of social relations? The sociologist can say something about society, but he cannot answer medical questions, so please do not expect from the sociologist anything more.

With that introduction, may I introduce Mr. Hilbourne, who is to speak on referral patterns for progressive eye disease.

PART V — SOCIOLOGICAL AND PSYCHIATRIC RESEARCH

REFERRAL PATTERNS FOR PROGRESSIVE EYE DISEASE: A PROJECTED STUDY

by Mr. J. F. H. Hilbourne, B.Sc.(Soc.), Department of Sociology, London School of Economics and Political Science.

This paper is not concerned with blindness as such but with an attempt to contribute something to the understanding of the social factors and mechanisms associated with delay in seeking medical help for progressive and potentially blinding eye disease. The research I am at present conducting in Bristol with the help of consultants from the Eye Hospital is only in its early stages: indeed field work has only recently commenced. More specifically, I am looking at referral patterns for two serious eye conditions, chronic simple glaucoma and senile cataract. Both are major causes of blindness in Britain contributing 22% and 12% of all registrations,[1] both occur in middle late and late life, and both are amenable to medical intervention.

Most people who receive medical attention do so either because they by themselves or in consultation with other laymen have decided it is necessary. Indeed the organisation of personal medical care is predicated on the assumption that the layman is in large part capable of discerning the signs and symptoms of physical or mental malfunctioning in himself or others for whom he may be concerned, of evaluating the meaning and implications of any such signs or symptoms as may be noticed in ways which are consonant with their clinical significance and deciding what action if any needs to be taken. He is also expected, within certain limits, to be able to differentiate between those signs and symptoms which, from the medical standpoint require consultation, and those which, like the common cold, he can be expected to cope with by himself. It is thus important to recognise, as Freidson has emphasised, that a considerable volume of disease and incapacity is managed, and is managed with medical approval without resort to professional care.[2]

In the past forty or so years an ever increasing body of research has pointed to the existence within the community of surprising numbers of people suffering from conditions for which medical help is appropriate, but who fail to present themselves for diagnosis and treatment. Again delay in presentation is a universal phenomena of medical experience with a number of important consequences both for the effectiveness and cost of medical care and in terms of unnecessary inconvenience, suffering and sometimes death. In terms of the present study those who suffer from chronic simple glaucoma and do not present until considerable visual deterioration has occurred have sustained an irreversable loss and further deterioration may be unavoidable. The senile cataract who does not present until well on in the progress of the condition has suffered unnecessary disability.

People learn to recognise disease and impairment as part and parcel of the general process of socialisation. A person's attitudes towards medical care as well as his ability to interpret and recognise symptoms in clinically meaningful ways are socially conditioned. They depend on his previous experience of illness and disability and the knowledge, attitudes and beliefs he acquires of these matters from his past and present social milieu. Koos[3] in a now classic study has demonstrated considerable class differences in the perception and evaluation of symptoms ranging from loss of appetite to blood in stool and urine. Zborowski[4] among others has investigated social differences in reaction to pain and Robinson[5] has recently published a study of definitions of and reactions to the onset of illness in Britain. In sum what is recognised as a symptom indicating pathology and the evaluation of the same symptom by different groups in society shows considerable and patterned social variation.[6] Where one or more of a set of symptoms which medically points to the existence of a condition requiring professional intervention has no lay equivalent or where the layman or groups of laymen evaluate them differently and in ways which are at odds with their medical interpretation then considerable delay in or failure to seek treatment will result.

Even where a layman knows that there is something the matter with him, the way he evaluates it and what he does about it is determined to a greater or lesser extent by factors extraneous to the condition itself. His symptoms and their perceived consequences are viewed in terms of their present and likely implications for his everyday life and the ways they impinge upon his everyday activities and relationships. For example, the consequences of a mild sore throat are entirely different for the lorry driver and the opera singer. The opera singer is more likely to consult his doctor while the lorry driver for whom the condition may be little more than a minor irritation is more likely to suck throat pastilles if indeed he does anything at all.

Similarly whether an impairment, whether associated with an illness or not, of a given type at a given level is recognised as such depends not only on its nature and pattern of onset, but upon situational factors in the life of the individual who has acquired it. Where the impairment is not associated with pain or discomfort as in many forms of impaired vision it is its impact upon and threat to an individual's activities, that is the degree of disability he recognises, that provides him with a clue that something is amiss. For example, the same level of defective acuity results in entirely different levels of disability as experienced by a housewife, a keen golfer, a bus driver or an accountant.

In sum for what conditions and symptoms people decide to seek medical help, when they decide to seek it and the decision processes involved are highly complex and subject to a variety of social influences. Some of these have been indicated by way of introduction and it is in terms of these that the problem of delay in seeking ophthalmic and ophthalmological attention must be approached.

Preliminary interviewing of patients in the Eye Hospital showed considerable denial both of the duration of their condition and the limitations it imposed upon them. Lay concepts of normal and hence abnormal vision are somewhat diffuse. They are cast primarily in terms of central visual acuity in so far as it affects an individual's perception and management of his material environment. Separate components of vision — field, adaption, accommodation and depth perception — are not distinguished or at least lack salience in lay conceptions of eyesight. As can be seen from reviewing what little casework evidence is available for the partially sighted, laymen have no readily available means of assessing the level of vision of an individual partially sighted person, nor can they easily or accurately infer the behavioural consequences of his impairment. Hence there is a temptation for many partially sighted people either to link themselves to the social stereotype of blindness by exaggerating their limitations or to pass as fully sighted. Senile cataract and chronic simple glaucoma have been chosen for study because of the contrasting ways in which these conditions affect visual impairment. The diminution of vision associated with senile cataract fits neatly into lay stereotypes of defective vision affecting as it does central visual acuity. On the other hand, chronic simple glaucoma proceeds by a reduction of visual field leaving visual acuity virtually unaffected until well on into its progress. Consequently it may be argued that the lay conception of vision operates against the early detection of such conditions as glaucoma which involve components of vision with which it does not deal.

Although some sociological research has examined patterns of medical care utilisation for various conditions together with lay definitions of illness and impairment as they affect utilisation, no such work exists for progressive eye conditions. My own study is therefore exploratory and is intended to map out the area for more detailed research at a later date. The research uses a case study approach and intensive interviews will be conducted with 200 patients aged between 40 and 75 presenting at the Eye Hospital with either senile cataract or chronic simple glaucoma. The 200 patients will be selected by taking patients presenting with either condition in its early stages (35 for each disease) and the first 75 presenting with each condition who have sustained serious loss of vision. For the purposes of this study, serious loss of vision is defined as a visual acuity of less than 6/18 in the better eye with glasses if worn at the time of presentation. The field criteria to be employed with glaucoma patients have yet to be finalised. Interviews will be conducted with patients in their homes. The nearest significant other (spouse or person the patient sees most) will also be interviewed and where appropriate asked the same questions as the patient. In order to minimise the effect of retirement and limit the questionnaire to manageable size, only female patients will be interviewed.

The questionnaire is designed to explore a number of areas which have been found relevant in understanding the mechanisms which bring about early and late presentation for other non-ocular conditions and disabilities. However since the division of labour in eye care between the medical and ophthalmic professions is unique and since we are dealing with conditions which primarily manifest themselves in the effects they have on functioning, the findings of these studies may not apply or may have to be substantially modified for eye disease.

Questions are asked concerning the patients path to the Eye Hospital, whom she has consulted and what advice and treatment she has been given or tried, her perception of her symptoms and her impairment and disability as it affects and has affected her everyday role and task activities. Information is sought on her previous ocular history and utilisation of ophthalmic, medical and lay sources of help and treatment for any eye problem she may have experienced in the past She is asked about her general health and the presence of other disabilities, her utilisation of medical facilities for non-eye conditions and an attempt is made to discover her overall attitude towards illness and disability. Her attitudes towards dependency are explored together with the degree to which she has been able to develop substitute functional equivalents to aid her in tasks for which she and others normally use their vision. Her family structure and contact, friendship patterns, leisure activities and organisational membership are explored and her age, socio-economic status and mobility, education and places of residence in the last ten years are noted.

Questions are asked of the lay significant other concerning their perception of the patient's impairment and its duration, the effect of her impairment on her everyday activities, her path to the eye hospital and dependence. The significant others are asked about their own attitudes and beliefs concerning illness and disability and any advice or help they may have given the patient, as well as about their own social background. Wherever possible exactly the same questions are used as with the patient covering, where it seems appropriate, the same areas.

Since the study has, as mentioned above, only just entered the field work stage it is impossible to present any results. Whether and in what ways this approach is useful in understanding how people seek treatment for progressive eye disease, and whether it can account in some measure for delay, I shall only be able to say in two years time when the data obtained from interviewing has been analysed and mulled over.

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DR. ROBINSON: Thank you very much. I have two questions, one a methodology one. How happy are you to do retrospective studies in this area? I was glad to hear that, given the choice between spreading your talent thinly over a wide area or really getting to the pith of what is going on in specific situations, you did the latter, but how happy are you that you are still dealing with people who have made these very early decisions?

MR. HILBOURNE: The answer to that is that from a theoretical standpoint I am not very happy with the methodology. Ideally I should like to take a random sample of persons aged between 40 and 70 from the community, give them eye tests and in this way have access to those who have not sought or obtained professional help. My feeling is, however, that with our present lack of knowledge in this area, a retrospective study like this can contribute something. It can define certain perameters, generate questions, and indicate lines of enquiry which might be followed up at a later date with a study using a more rigorous methodology. As it is I try to interview patients as soon as possible after a diagnosis of their condition has been obtained.

DR. ROBINSON: May I invite further questions?

MR. WALL: I suppose that these people get to the hospital via someone else? Presumably, they go there from a general practitioner or an optician. Would any of them come direct to the hospital?

MR. HILBOURNE: Yes. The sources of referral and the process involved are extremely complex. In the initial stages of the study I went through a series of hospital notes and found that the majority of patients were referred from opticians. A small proportion were referred directly by their general practitioners without having seen an optician or came directly to the hospital.

One of the points that needs stressing is that the reason for a patient seeking professional help, even if his sight is seriously impaired, may have little to do with his vision. One old lady of 80 whom I interviewed recently started to wear glasses at the age of 50 and stopped doing so ten years later because she said that the print in the local paper had been changed and consequently her spectacles were of no further use. When she came to the Hospital she was registrably blind as the result of bilateral senile cataract and had been so for many years. Her presentation had nothing to do with her vision, but resulted from the fact that her eyes had started to water and this disturbed her. Another patient came to the Hospital, again registrably blind, because his doctor had failed to clear up conjunctivitis. No mention was made of the patient's sight in the referral letter.

MR. WALL: The thing I was going to pursue on this particular point was whether there is any danger of interception by a G.P.? Do they for instance, regard the condition as being one of old age for which there is no remedy?

MR. HILBOURNE: I suspect that some patients are considered too old for referral for specialist diagnosis and treatment. On the other hand a number of investigations among the elderly have shown that G.P.'s are not always aware that some of their elderly patients are disabled.

MR. A. I. FRIEDMANN (Royal Eye Hospital): I think that general practitioners use the optician quite a lot because he must produce a better diagnosis, but I agree that it is a really complicated referral situation.

MR. S. MARCUS (Jewish Blind Society): Do you find a different referral pattern among people in different social classes?

MR. HILBOURNE: As yet I do not have enough data to be able to say whether this is the case. I can only say that I would be extremely surprised if it were not so. Research on lay definitions of illness tends to indicate that symptoms are differently perceived, evaluated and acted upon by different social classes. For example in Dr. Robinson's recent book he indicates that fatigue may be seen as a sign of illness in the middle class but not in the working class. In America there is a considerable volume of work dealing with the effects of social class on the ways in which symptoms are perceived and what people do about them.

MR. S. J. CREWS: This study is essential. We are trying to get G.P.'s and sociologists together in a similar study in Birmingham. Have you any data as to how many patients go first to the chemist and only later to the G.P.? This might be something that should be looked at because by going back to the chemist and making him aware of the significance of an investigation, one might get the patient to go back to the G.P. As far as I know, very little work has been done on the community question.

MR. HILBOURNE: One of the difficulties of work in this area is that there is so little previous research to go on. It is perhaps worth pointing out that the Jeffrey's study in the early sixties would indicate that even where a person is receiving professional medical help he may still continue to utilise alternative sources of advice, and lay and patent remedies for his condition as he sees it.

Dr. H. Heath: Would it be possible through your survey to answer the question, why are so many people registered as blind with cataract? It would be interesting to know why some people with cataract are not operated on.

Mr. Hilbourne: I think the answer is that this study would not deal with that question.

Dr. Robinson: I shall have to draw the discussion to a close now. Thank you very much Mr. Hilbourne.

Our second contributor is Miss Margaret Voysey, who will speak on some social aspects of diabetic retinopathy.

SOCIOLOGICAL ASPECTS OF DIABETIC RETINOPATHY

by Miss Margaret Voysey, B.Sc.(Econ.), Bedford College,
University of London.

ABSTRACT

The paper had two objectives:—

(1) To outline proposals for a projected three year study sponsored by the British Diabetic Association and commenced in September 1971 of the problems facing persons suffering from or responsible for managing various aspects of diabetic retinopathy.

(2) An attempt to relate some of the results of an earlier study of parents with a handicapped child carried out by the same investigator to the present study.

(i) The study will develop the findings of a small-scale pilot survey carried out by Alison Watson for the B.D.A. in 1968-9. Two underlying themes appear important:—(a) the relationship between clinical signs of D.R. and behaviour; (b) the social processes involved in rehabilitation or adjustment to visual impairment caused by D.R. Research methods will include participant observation and semi-structured tape-recorded interviews in three main locations:—diabetic out-patient clinics; residential rehabilitation institutions and the homes of persons with D.R.

(ii) Focussing on the specific issue of doctor/patient communication during the onset of D.R. and any consequent visual impairment some of the problems involved were discussed. In order to clarify the kinds of phenomena with which this part of the study will be concerned use was made of analogous findings about the strategies doctors employ to manage encounters with parents who have a handicapped child and conversely, those that parents may adopt in an attempt to discover what is wrong with their child.

Dr. Robinson: Thank you, Miss Voysey. I invite questions straight away.

Miss Alison Shaw: May I ask if in your patient/doctor relationship with diabetic cases you have been looking at diabetic cases where retinopathy has not been suspected or diagnosed?

Miss Voysey: I am not actually sure what to do about this. I was interested in finding how a doctor/patient relationship operated.

Miss Shaw: I was thinking, as a question of information, whether patients do or do not want to be told of the possibilities, not the actuality.

Mr. A. I. Friedmann: How much difference do you think it makes to the relationship in this situation?

Miss Voysey: I do not know. It is always difficult to judge this. I do not know what would happen if I were not there. There is one point, several people who have used a tape-recorder in interviews have said that it does not seem to make any difference. One might think that it would make the person very nervous but I have found that many soon forget that it is there.

Dr. Heath: You are going to ask the patient whether the doctor tells him, but are you going to ask the patient what he tells the doctor and whether he tells the doctor all he should know? They may have two or three months of appointments and be judged to be all right, but the doctor may not know that for three months they have been out of blood sugar control.

Miss Voysey: Yes, I have certainly noted that. This is partly because, when they have not a complicated diabetes and it does not appear to be very serious, their apparent attitude is like that of an ordinary person trying to lose weight and not trying to deal with the dietary question as seriously as they should.

Dr. Anne Hayman: I want to congratulate Miss Voysey on attempting this vitally important study which obviously has aroused a great deal of interest. I cannot say a great deal about the diabetic, but on the general problem of the doctor/patient relationship what Dr. Heath has said reminds me of one of the problems. The patient may say, "Why didn't you tell me?", but at the time it may have been very difficult for the doctor to recognise the condition. A great deal of work has been done on this. The only point I add to what you have said is to ask whether you might be able to devise some way of looking at the doctor's problems when trying to explore this relationship. The question of why some doctors want to tell and others do not may be connected with the doctor's own way of dealing with a case. Here is an enormous field for inquiry.

Mr. T. J. Parker: I should like to make a comment on this doctor/patient relationship, more or less from the patient's point of view. There seems to be a feeling that you must never tell a blind person ; we seem to be treated in a different way from sighted persons. I do not know whether there is any blind person in this room who has not had the experience of hearing someone ask about him, "Does he take sugar in his tea?", as if the person concerned were not present.

I think that a lot of difficulty is due to the high number of unemployable blind people in this country. You go to the doctor and you merely know that he is writing something and then he says, "Come back in three weeks time". This can go on for a couple of years and you do not know why. It would be useful to find how long some of these people have been going to the out-patients' department before actually being told what it is for. People who are likely to become blind are not cowardly in their outlook. I have met thousands and I find that they develop a sense of humour. They get irritated and excited the same as they did before they went blind. It would be better if this question were faced and they were told what the chances were so that rehabilitation might take place before they develop an unemployable outlook. A lot of cowardice is involved in not telling a person that he is likely to become blind. To tell him is of value in his future life because then he can face the problem and get training instead of becoming unemployable.

MR. MARCUS: May I ask a question on the point made by Dr. Heath? My experience with the children of handicapped parents shows that where so much breaks down is when the doctor does not know what is available in the home, or the patient does not know what is available for him. This is why so often they do not " come clean ". It is desperately important when dealing with children of handicapped parents and also with adults. Someone has to make a purposeful and progressive step so that it can be seen that there is something ahead.

A MEMBER OF THE AUDIENCE: I am glad that there has been this discussion. I believe that the problem, not only what to tell the patient, but how to tell the patient, is very important to those of us who are interested in sociology. There is the additional question of how the ophthalmologist should tell the patient what is available, and the quality of the information.

Dr. Robinson closed the discussion for a coffee interval after which he called upon Dr. Anne Hayman.

SOME DEVELOPMENTAL PROBLEMS IN BLIND BABIES AND TODDLERS

BASED ON

CURRENT RESEARCH AT THE NURSERY FOR BLIND CHILDREN, HAMPSTEAD CHILD THERAPY CLINIC

by Dr. ANNE HAYMAN, M.B., B.Ch., D.P.M., Research Psychoanalyst,
The Hampstead Child Therapy Clinic.

This is discussed briefly under two heads. Firstly, the continuation of past work (results of which have led to some publications) in exploring the ways babies born blind develop differently from sighted babies. A specific new field has been visiting the homes of blind babies from the start, with some results being mentioned.

Secondly, a new field comprising observation of so-called " blindisms " in babies, toddlers and young children, with the aim of understanding their specific functions and indirectly, contributing towards elucidating the role of sight in ordinary development.

I have been asked to say something about the research now being done on blind children at the Hampstead Child Therapy Clinic. We run a very small nursery school for blind toddlers set up by Mrs. Dorothy Burlingham about twelve years ago, and keep contact with the children after they leave. Study of how young children react to the lack or loss of sight, made us aware that the early development of babies born blind follows a very different course from that of the sighted young. Those becoming blind in the first or second year are again different from those who have never seen. This finding led us to extend the service side of our work to include contact with the mothers of blind children from their earliest days, involving frequent visits to the home for guidance and of course observation, with these children being able to enter our nursery when they are three.

I shall discuss our current research under two headings. Firstly there is the continuation of the observation of the young blind of various ages, which has already led to a number of publications. Secondly, in the past year we have begun to concentrate our efforts on the so-called " blindisms ", which (as you know) are certain habits that show marked persistence in the young blind.

Firstly, as regards research into the early development of blind infants. One of the now well-known facts revealed by psychoanalytically based and other research, is that normal development of any child requires the continuing early presence of a devoted mother (or substitute) who is able to meet her child's prime needs. These consist initially of a total response to the infant's requirements including, not only all the physical care necessary to survival, but also an emotional dedication that the ordinarily devoted mother gives without thinking about it, which includes her pleasure and delight in her baby, so that she will cuddle him, sing to him, respond to his smiles and gurgles with smiles, movements, cuddling and so on. As the months pass and the sighted baby begins to show increasing interest in the world around him, the mother automatically begins to foster his doing things for himself. For example, once he starts picking up something he sees, she will put it within his reach instead of putting it in his hand. It is at this stage that one of the differences in blind babies begins to show, because, as he cannot see objects, he does not reach out for them. He may have begun to smile at an age more or less comparable with that of sighted children, but he will never have had the experience of smiling at a smiling face; thus the primordial stage of human relationships, of the baby imitating what he sees and begins to recognise as his mother, are different in the infant born blind. Psychoanalytic work has led us to the view that, during the first year, the usual baby gradually integrates what he has seen, heard, smelt, tasted and touched of his mother into one coherent image; but for the baby born blind the vital contribution of sight is lacking, and he is left with the problem of integrating what he has only heard, touched, smelt, and so on. The problem here is that sight is a far more discriminating method of understanding what is perceived, than any of the others. Sound, for example, on which the blind rely so much, is a far less efficient mechanism for grasping details, and distinguishing between them. By the end of the first year the sighted baby is looking around him and getting a picture of the distant world. If his mother puts a bottle on the table he will recognise it and become aware that he cannot reach it, and begin therefore to understand distance. But this the blind baby cannot do. This begins to show when he becomes mobile, as blind babies are often distressingly "good". Not seeing the world, they have no stimulus to go out and explore it, and are only too prepared to stay quietly in one place.

From what I have just said it becomes clear that mothers of blind babies have a far bigger task than mothers of sighted ones. Development is constantly stimulated by what is seen, and the blind baby's mother has to make up for this lack by constantly stimulating and eliciting his interest in the world. As the mothers of babies born blind or becoming blind early are understandably likely to be unhappy and depressed, this is just the sort of thing that is additionally difficult for them. One thing we have learned, from our more recent work in visiting the homes of blind babies, is that the focus of need, especially in the first year, is not so much the baby as the mother — which should not be surprising, as we all know how mothers assume the functions that the baby will do for himself later. It has been rewarding to discover how much mothers, and therefore the babies, can be helped by consistent, tactful, sympathetic understanding and guidance, embracing the two fields; firstly, of helping the mother cope with her own unhappiness and withdrawal; and secondly alerting her to the ways in which she can supply cues her baby can recognise via modalities other than sight.

Secondly; the so-called " blindisms ". In the first year one of the most frequent and persistent of these begins to show, namely the habit of rocking. Rocking is not confined to blind babies. Nearly all the young do it to some extent. They may bounce on their mother's knee or rock for a while when preparing to stand up, or just to amuse themselves; but in the sighted normal young this activity is soon mainly superseded by other bodily achievements, such as crawling, and walking and so on. Rocking appears to be a very primitive method of achieving the bodily stimulation and pleasure of movement. Traces of it certainly remain, as seen in the young child's pleasure in a rocking-horse, the widespread delight in swings, etc., and dancing, which persists into later life. It is also observed in a very wide range of conditions, of which one more normal is the state of deep distress, when many adult people may sit and rock; at the other extreme it may be seen continuously in, e.g. some defective or brain-damaged people. The easy reversal to, or persistence of, this primitive type of movement, shows that the possibility of doing it is always available to anyone; but in the blind baby or young child it is vastly more persistent. Blind toddlers, who are not stimulated by sight to explore, are understandably reluctant to move out into the world; they are also anxious because they can so easily bump into or trip over things. And thus, in the first part of the second year it is only too likely that the toddler will substitute rocking for the usual pleasurable activities of the sighted toddler. He will also do it to comfort himself. All toddlers have their self-comfort methods, a common one being curling up and sucking their thumbs. This is sometimes seen in the blind (although we are beginning to have the impression that blind infants do it less than sighted ones). Often rocking is resorted to when a sighted child might run to his mother, or when he might have a temper tantrum; blind toddlers have far fewer of these. They are much less openly aggressive than the sighted (which must have a lot to do with their very great dependence).

The habit that is far commoner among blind children than in any others, is eye-poking, or handling, of which there are many variants. Two different explanations may account for some of these. Firstly, eye-rubbing may be caused by the chronic irritation some babies suffer in their eyes following surgery, etc., which could easily focus attention and interest on this area. Secondly, some children with minimal or no vision might be able to get some visual stimulus from poking the eyeball gently, on the same principle that any sighted person " sees stars " when his closed eye is compressed; in such a case, the child is surely doing it for pleasurable interest. There is this action (demonstrate — pulling the corners of the eyes) and this (demonstrate — pressure on top of closed eyeballs) and so on. Then there are children who sit or walk with one or both eyes fisted (demonstrate), and while *this* may serve either of the needs mentioned, it may also partly be an abnormal prolongation of normal forms of eye touching, such as rubbing the eyes when tired (seen from about three months).

Like rocking, all these habits apparently supply both primitive comfort, and autoerotic gratification. Then there is twirling, the child spinning around on one spot, which is partly explicable by the blind child's fear of moving in unseen spaces. Finally, there are some odd head movements that such children sometimes show.

Our interest is to try and see how these various habits differ from, and develop away from, normal development, and to understand the special functions they serve. Why these particular modes of comfort and gratification? At present we are making detailed observations of these habits from the first year onwards; and are working to contrast them, not only with the sighted child's actions, but also with the unusual movements seen in borderline, psychotic and neurologically damaged children. We hope in this way to single out habits specific to blindness, to help us understand a little more fully how development in the blind differs from that in the sighted; and thus, also, to understand something more of the specific role of sight in early human development.

Dr. Robinson: Thank you, Dr. Hayman. Are there any questions?

Mr. M. S. Colborne Brown (Royal Nat. Inst. for the Blind): The heading of your paper is "Emotionally Disturbed Infants/Children", but in fact practically everything concerned in the paper is confined to blind children.

Dr. Hayman: You are absolutely right. I did not change the heading early enough. This might have led some people to think that I was going to talk about what neurotic disturbance happens when a child goes blind, but I was going to speak about the actual kind of mile-posts in development of blind babies and children.

Mr. Colborne Brown: What you say confirms all that we have found in the last dozen or so years. Help for parents of blind children is not only a useful service to the inadequate parent, but a useful part of the child's development. The blind child learns by touch only in relation to the kind of help which the sighted person gives. The blind child does not learn by touch in the same way as a sighted child learns by sight. This is something which we cannot say often enough — that help to the parent in this field is not a kind of social service, but is fundamental for the child.

It is interesting to consider a question which links up with this. To some extent we over-estimate mannerisms in the blind child. Mannerisms are wider in range than habits and no one has done a study of mannerisms in sighted children.

Many young children have remarkable facility in moving about the ground and then rocking, but where there is a field for exploration is in the blind child's ignorance of its body and in the natural movements of its body. I think that many of the seeming mannerisms come from abortive mannerisms. In Holland much has been done in teaching children how to move their bodies and you see totally blind children skipping around quite naturally. I feel sure that this has something to do with the actual physical comprehension of the body. Some of us think that totally blind children are not so active because of the way in which they have been handled and carried about.

Dr. Hayman: I absolutely agree about the need for the blind child to know, to learn about and become acquainted and familiar with his own body. I can find nothing to disagree with what you said. Indeed, in our nursery, a lot of attention is given to games acquainting the children with their bodies and also converting meaningless activities like rocking, etc., into games like see-sawing and dancing to music. Your idea about mannerisms raises a point. You have talked about children running around and about the development of blind children. Blind children's development may not ultimately be held up. You certainly may get these children running around. Eventually I wonder whether this part of a young person's behaviour, with the stopping to rock, might be an anxiety, a momentary regression from an ordinary way of doing things. I do not think that this observation necessarily cuts across the sort of way we are beginning to look at these things, but what you have told us can enrich our findings enormously.

Mr. G. Slaughter: Do you find some blind children — I am speaking only from my own observations—become as adventurous as sighted children? They hear the knives and forks rattle and are attracted to the table. I noticed when I went to a blind school that some of the children were too adventurous, almost reckless. They would find a flight of steps, or a ladder which one of the maintenance men had been using and this could become dangerous for them.

Having had experience of both a sighted school and a blind school, it seemed to me that there was as much adventurousness in the blind as in the other pupils. I found a little girl investigating a wringer with her fingers and she had to have attention given to her fingers. I know a child with more scars on his hand than other children have because he investigated a fairy cycle and became quite adventurous at an early age.

Dr. Hayman: Yes, of course, blind children are children after all. There are the adventurous ones and those who are not so careful. This poses a question about the watchfulness and care for them that must be maintained.

Mr. Colborne Brown: I have a theory that this rocking has to do with cause and effect; it is a highly sophisticated process and what appears to be a lack of knowledge of consequences.

Dr. Hayman: I think that I should say a word about something which I mentioned earlier. There is a difference between all sorts of children born blind and those who go blind while still young.

There are two or three things which may relate to the differences between the child who will run down a path with his head held up and one who has his head down. You could see a little boy of 4 running with his head held up in a beautiful posture. This is a child who had both eyes removed at 16 months, but he had some vision before that and could get around. This child had a perception of living things and all these things seem to play an enormous part in what comes out of a child and what use children make of whatever faculties they have.

Cause and effect is something which I do not want to go into in great detail because the development of conceptual thinking in the young blind is a topic we are still pursuing and I do not have much to say about it yet but in the whole area of pre-stages of intellectual development there is an important starting-point in the early emotional relationships, with hold-ups in some of these people born with a sensory deficit. This seems related to later interference in abstract thinking, as in understanding about cause and effect. You may have a child threshing about senselessly and wildly and also a child who may be ordinarily anxious, neurotic and overbearing in an attempt to deny that he is frightened. There are so many different levels of disturbance in this sort of thing.

Mr. W. Thornton: One of the things which excites us is the prospect that ultra-sonic spectacles such as I am wearing might be of use to young children. Would Dr. Hayman like to consider that?

Dr. Hayman: Thank you.

Dr. Robinson: Thank you very much.

Mr. Williams, of Lea Hospital, Bromsgrove, will now talk on an experimental study of the function of mannerisms in the deaf-blind rubella child.

A FUNCTIONAL ANALYSIS OF STEREOTYPY IN THE RUBELLA CHILD — INTRODUCTION AND BACKGROUND TO THE PROBLEM

by Mr. C. Williams, M.Sc., A.B.Ps.S., Research Psychologist,
Lea Hospital, Bromsgrove.

Casual observation of a group of subnormal rubella syndrome children will confirm the findings that much of their activity involves the performance of repetitive and stereotyped movement patterns. Many of the children will be seen rocking, head-banging, eye-poking and arm-flapping.

Previous research reports provide data on the frequency of such behaviours. Kaufman and Levitt (1965) observed rocking to be present in 69% of a sample of 83 retarded patients. Berkson and Davenport (1962) give a figure of 66% and conclude that there is a negative correlation between the presence of rocking and intelligence.

Ballinger (1971) quotes a frequency of 15% self-injury in a sample of 631 retarded patients whilst the frequency of similar behaviours in a psychiatric population was only 3%. Similarly Donoghue (1971) has found a 7% frequency of mutilation in a group of 148 children.

These findings then suggest that stereotypy and mutilation are functions of—

1 — Institutionalisation

2 — Subnormality

3 — Social handicap

4 — Age of subjects.

The presence of stereotypy in a child's behavioural repertoire can be seen as maladaptive in so far as it actively interferes with the learning of more appropriate behaviours and poses a major management problem to nursing staff. Donoghue (1971) says " although self-mutilation occurred in less than 10% of the group studied, the *quality* of the self-mutilation caused more distress and additional work for the nursing staff than did, for example, a greater *quantity* of destructiveness by the patients ".

To date a number of hypotheses have been generated to explain stereotyped behaviour in the retardate. These various hypotheses can be subsumed under two headings: an arousal hypothesis and an environmental hypothesis.

The arousal hypothesis: this hypothesis is best described in the words of Berkson—

> " stereotypies serve some self-stimulatory function. This general view involves the assumption that the organism has a need for certain levels of more or less specific types of stimulation. In the ordinary course of events, these needs are met by the social or physical environment. But when isolation or some other unusual condition is imposed, these sources of stimulation may be reduced and the organism, in order to fill the deficit, begins to provide his own stimulation ".

Whilst Hollis (1968) is a protagonist of the environmental hypothesis, viz: " the data support the hypothesis that body-rocking movements in the retardate are operants—and—it was concluded for the retardate that the rate of stereotyped rocking movements depends primarily upon the consequences produced by the alternative activity and only secondarily, if at all, upon the subjects arousal level ".

This study will present the research data presently available in support of each of these two apparently conflicting hypotheses and attempt to reconcile them in the light of my own studies on stereotypy.

Berkson and Mason (1963) have reported increased frequency of stereotyped movements when their subjects were placed in a restricted and novel environment.

In-work on chimpanzees, Davenport and Menzel (1963) demonstrate that stereotypies can be induced to occur following rearing in a restricted environment that is, one lacking in the normal level of stimulation provided by the mother.

Kaufman and Levitt (1965) quote studies in which high rates of stereotypy have been related to low responsiveness to the environment: (and will therefore interfere with the learning of appropriate behaviour patterns).

They noted the high prevalence of rocking reported in blind children, and conclude " partial or complete loss of a sensory modality can be conceived of as a factor producing a natural state of sensory deprivation and, in turn, such a state can foster the continuation of stereotyped behaviours in mental defectives ".

In a series of papers by Hollis (1965, 1968) he attempts to establish an environmental hypothesis for the aetiology of rocking behaviour in severe retardates.

His major work (1968) shows how contingent food reinforcement can be used to—

(a) establish new rocking patterns in a patient previously without such behaviour—

(b) increase and decrease rate of rocking according to the schedule of reinforcement.

Lovaas and Simmons (1969) present convincing data in support of an environmental theory. In studying a group of three retarded children characterised by severe self-mutilation, they established that—

(a) an extinction procedure is sufficient to eliminate mutilation in certain cases provided sufficient sessions are used.

(b) the delivery of aversive stimuli contingent on mutilation serves to suppress it—and

(c) contingent social attention serves to increase the frequency of mutilation.

From these findings they established the hypothesis that self-mutilation can be considered as " a learned social behaviour that is maintained by social reinforcement ".

It can be seen that both Hollis and Lovaas are arguing for a social reinforcement theory serving to maintain stereotypy and, ultimately, mutilation. (It is to be argued that a behavioural continuum exists from stereotypy to mutilation along which a child can move as a result of inadvertent shaping procedures). The problem of the genesis of such acts is not so fully discussed in their hypotheses. It may be necessary, therefore, to speculate on the aetiology of stereotypy apart from its subsequent maintenance.

The results of these studies can be tabulated to indicate their respective affiliation to either of the two major hypotheses—

Arousal	*Environmental*
Sensory deprivation	Contingent social reinforcement
Ambient arousal level	Punishment effects " self reinforcement ".

Data will now be presented from a number of studies to provide support for a combined arousal-environment hypothesis.

1. *The relationship between an index of arousal (heart rate) and Stereotypy.*

An investigation was undertaken to establish a relationship between arousal and stereotypy in an autistic child as indicated by Hutt (1965) who used E.E.G. as an index of arousal.

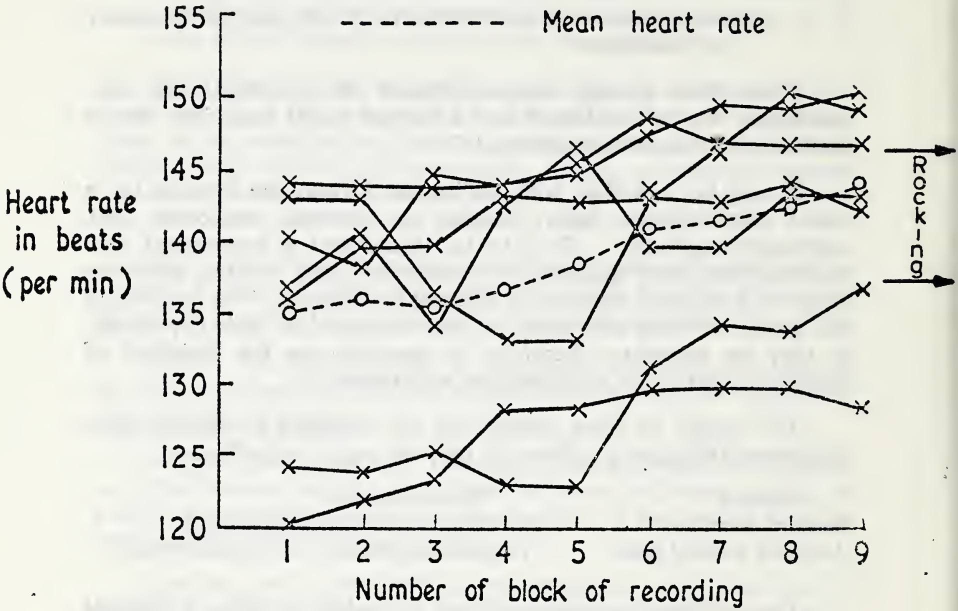
A 3½ year old girl, previously diagnosed as showing characteristic signs of autism was studied using telemetered heart rate monitoring coupled with observation of onset and duration of rocking (Williams 1969).

The results of this study are presented in graph 1 and clearly indicate that on the seven pre-rocking sessions observed there was a significant increase in heart rate preceeding that onset (p. $<$ ·01).

These findings were interpreted in terms of a model incorporating the theory of cyclical distress of the newborn of Kesson and Mandler (1961) and relating this to a deficiency in learning in autistic children

GRAPH 1

Graph of heart rate against number of block of recording for each of the seven pre-rocking trials.



whereby the normal development of secondary inhibitors of stress is predicated by their neurological disorder and, hence, the maintenance of primary stress inhibitors (viz. — rocking) as a major component of their behavioural repertoire is strengthened.

Further psychophysiological data on the faulty modulation, and hence, presumably abnormally fluctuating level of arousal, has since been collected from a larger group of autistic children through a similar monitoring of base-line heart rate. (MacCulloch and Williams 1971).

A hypothesis can therefore be erected to account for rocking in autistic children relating it to—

(a) a chronic and un-modulated state of hyper-arousal.

(b) a failure to acquire appropriate behaviours to inhibit (control) this arousal.

(c) the inherent reinforcing properties of rocking *per se*.

2. *Studies of the stereotypy repertoire in a deaf/blind child.*

An observational study is in progress recording the frequency and duration of stereotyped movement patterns in a rubella syndrome child under various environmental conditions. A note has been made of the functional relationship of this stereotyped behaviour repertoire and the experimental contingencies.

Subject.

One male child aged 8 years has so far been extensively studied. He has been diagnosed as rubella syndrome with attendant disorders of bilateral congenital cataracts and a bilateral auditory perceptive loss of 50-60 dbls. He has a congenital heart defect, microcephaly and is severely subnormal in intelligence.

Method — Part 1.

A standard ethological procedure of a continuous taped commentary of his behaviour has been made covering a total observation period of approximately 2½ hours in ten minute sessions. These tapes are subsequently transcribed and the behaviour units are timed. This procedure allows a measure of both frequency and duration of each behavioural unit to be computed.

Two conditions of free-observation have been investigated:

Condition 1. The behavioural repertoire whilst restrained in his feeding chair, but otherwise free to move, under conditions of no stimulation apart from the ambient noise level of the observation room. This condition is subsequently referred to as Non-vibration.

Condition 2. The behavioural repertoire under identical conditions as above but with a tactile stimulation unit placed against his back beneath his clothes. This condition is subsequently referred to as " Vibration ".

(*a number of slides showing the mannerisms of the subject were presented here*).

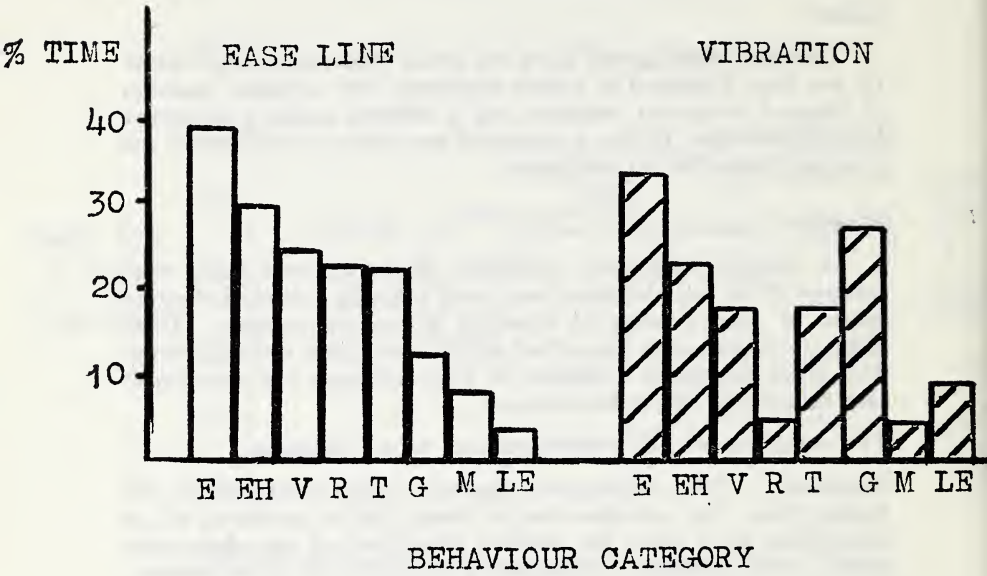
The frequency and duration of the major components of the behavioural repertoire of the subject (see table 1) are plotted to form an ethogram of the two experimental conditions (diag. 1 and 2).

Condition 1. From this it can be seen that up to 40% of the total observation time is spent as " Eye poke " whilst " Gaze " (i.e. absence of stereotypy) only occurs for 11% of the total time. The total time of stereotypy exceeds 100% when each item is summed, since many stereotypies occur simultaneously. This is particularly so for " Ear hold " " vocalisation " and " rocking " which form a behavioural triad (EH. V. R.).

Condition 2. Under continuous vibration the relative frequency ot the behavioural repertoire is modified. From diagrams 1 and 2 it

DIAG. 1

SUBJECT: M.D.
TOTAL TIME: 188 MINS. 38 SECS..



ETHOGRAM OF RELATIVE DURATIONS OF STEREOTYPY UNDER TWO CONDITIONS

TABLE 1

BEHAVIOUR CATEGORY: **SUBJECT M.D.**

T : THUMB SUCKING
E : EYE POKING
EH : EAR HOLD
V : VOCALISATION
R : ROCKING
G : GAZE
M : MOUTH PLAY
LE : LEFT EYE POKE

can be seen that there is a general reduction overall in amount of time spent in stereotypy and a corresponding increase in per cent. time of gaze (p. = ·001). The total relative frequencies for stereotypy and non-stereotypy are, for Condition 1 (non-vibration) stereotypy 20·72% and gaze 11·11% (p. = ·001) and for Condition 2 (vibration) for stereotypy 14·55% and gaze 25·55% (p. = ·001).

It is therefore apparent that continuous tactile stimulation produced by vibration has a marked and significant effect in reducing per cent. time spent in stereotypy from 21% to 15% whilst correspondingly increasing per cent. time spent in non-stereotyped activity from 11% to 26%.

Part 2.

In the above study vibration was applied on a continuous basis with the expectation that tactile stimulation would have arousal increasing properties. In this second part vibration is studied as to its possible reinforcing properties when used on a contingent basis.

Vibration was made contingent upon " gaze " and was presented on a continuous schedule—i.e. every period of " gaze " was associated with a period of vibration with onset and offset of vibration corresponding in time with onset and offset of " gaze ".

Each session began with a period of free observation, followed by the contingent vibration period finishing again with free observation in an ABA design of base-line—conditioning—base-line.

On one occasion a reversal procedure was investigated to demonstrate the reinforcing property of tactile stimulation on behaviour other than " gaze "; in so far as vibration has properties that increase per cent. " gaze " as a function of tactile stimulation apart from any contingent reinforcing properties as evidenced by the earlier report on continuous vibration. To test this hypothesis vibration was made contingent on " stereotypy " being a reverse in the design where it was contingent only on " gaze " or absence of stereotypy.

If vibration has inherent reinforcing properties that outweigh its arousal increasing properties then that behaviour contingent with vibration should show an increase in frequency over base-line whether or not it is a stimulus seeking behaviour that is being conditioned.

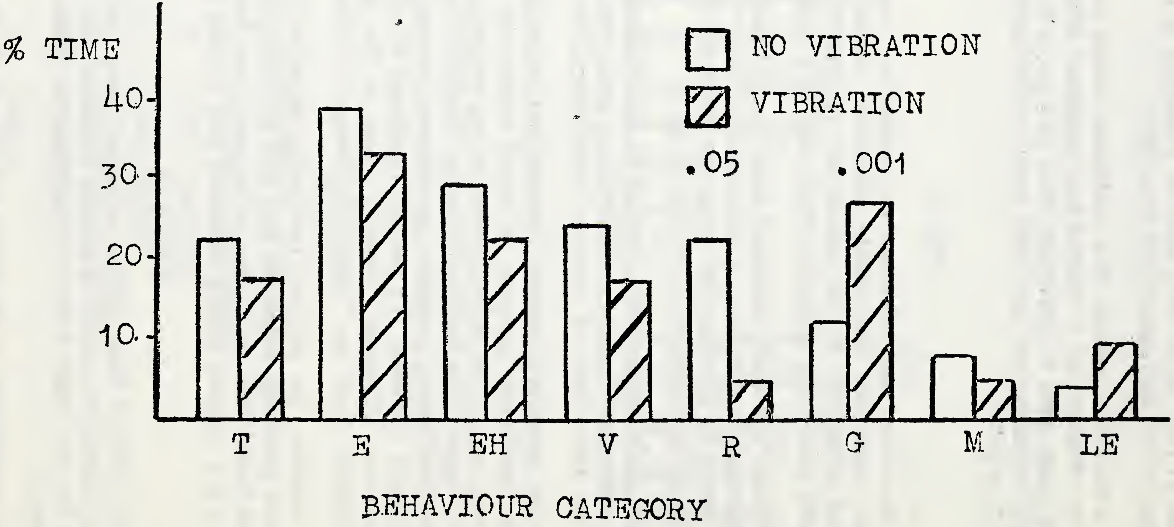
RESULTS

The results of these various conditions have been plotted on a series of cumulative curves of relative frequency and duration over time of the two major behavioural components studied — gaze and stereotypy.

The co-ordinates of the figures are in units of time horizontally for duration of *stereotypy* in seconds whilst vertical time being for duration of *gaze* in seconds.

DIAG. 2

SUBJECT: M.D.
TOTAL TIME: 188 MINS. 38 SECS..



ETHOGRAM OF CHANGE IN RELATIVE DURATIONS OF STEREOTYPY UNDER TWO CONDITIONS

The *relative frequency* of the two behaviours can then be readily computed from the *slope* of the curve so produced as can any *changes* in their relative frequency from the *change* in slope.

Figure 1 provides data on base-line (NV1) and continuous vibration (V) showing the increase in % gaze over time.

It is clear that the effect of continuous vibration does not generalise to non-vibration conditions (NV2).

Figure 2 shows how contingent vibration (C.V.) greatly increases the per cent. gaze condition over base-line, again having no generalisation effect.

Figure 3 has data on the contingent reinforcement of stereotypy showing how, early in the session, per cent. stereotypy can be maintained at a base-line rate even though vibration is present. There is a period when per cent. gaze increases in frequency over base-line before reverting to the base-line operant level. When the conditions are reversed and vibration is once again made contingent on gaze the usual per cent. increase in gaze is produced. An extinction effect is beginning to be apparent.

Summary of Results.

1. The relative frequencies of the subject's behavioural repertoire under free observation remain constant over time. These can be plotted in the form of an ethogram that gives an ethological profile of behaviour patterns specific to one child. Subsequent plottings of the ethogram can be used to detect changes in the relative frequency of behaviours over time under differing experimental conditions.

2. Under continuous vibration there is a significant reduction in the per cent. time stereotypy with a reciprocal increase in per cent. time gaze.

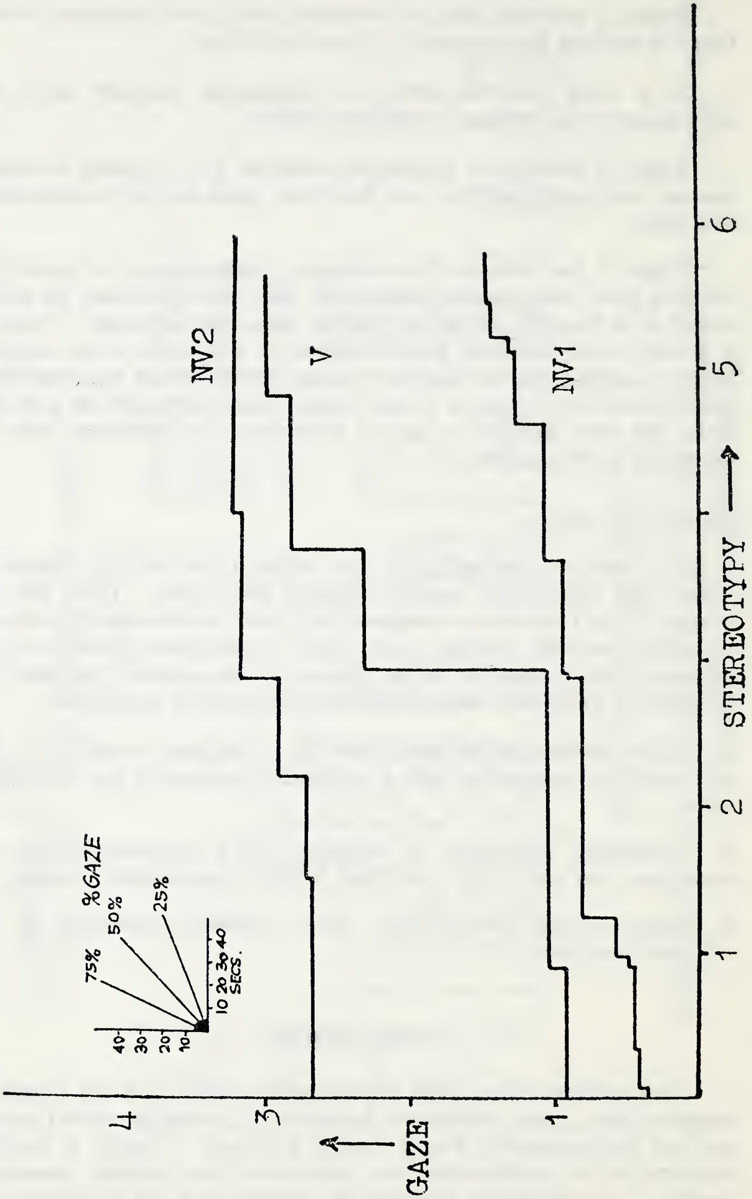
3. Contingent application of vibration has a reinforcing effect on both gaze and stereotypy according to the experimental schedule.

4. There is little generalisation effect following extinction of the vibration condition.

DISCUSSION

The evidence from both experimental studies and the literature suggests that a clear distinction between an arousal mediated theory and an environmental theory cannot be made. Clearly a realistic approach is to combine the two approaches into a single theoretical model. The distinction between the arousal and the environmental hypothesis being based then on a temporal separation of the two " causes ".

FIG. 1



GAZE
4
3
1
STEREOTYPY
1
2
5
6
NV2
V
NV1
%GAZE
75%
50%
25%
40
30
20
10
10 20 30 40
SECS.

FIG. 2

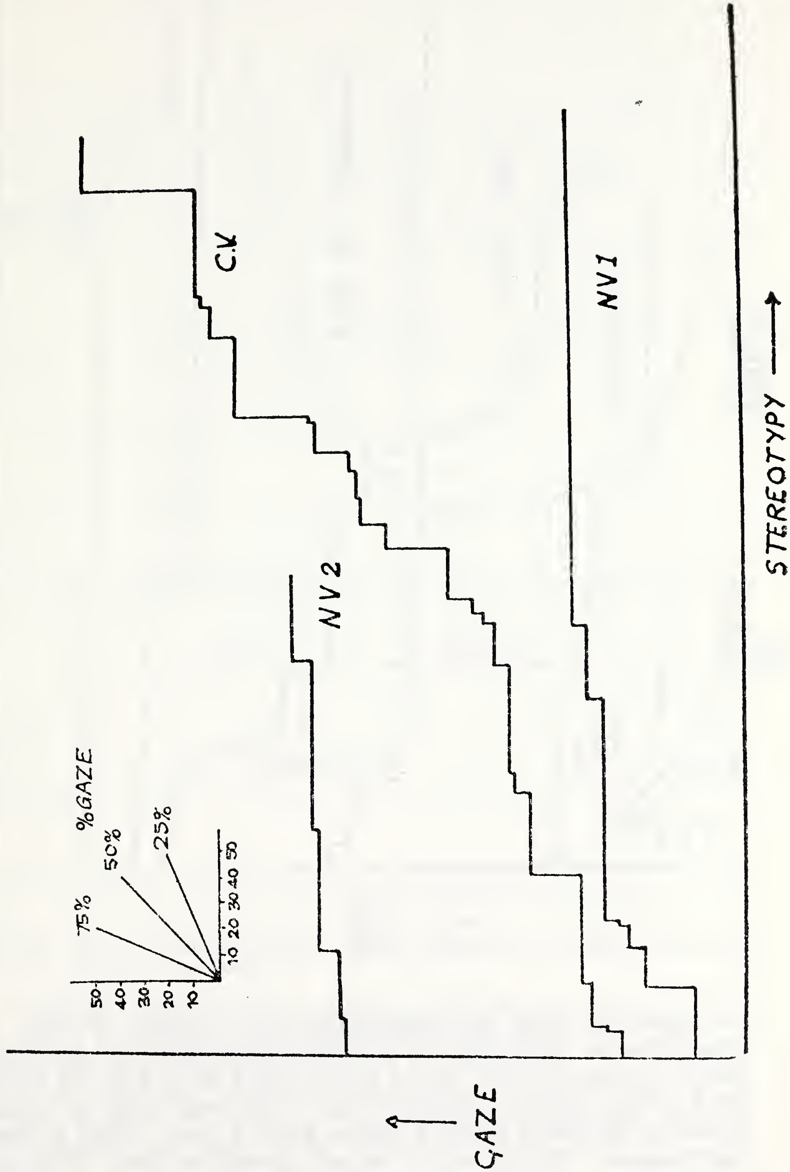
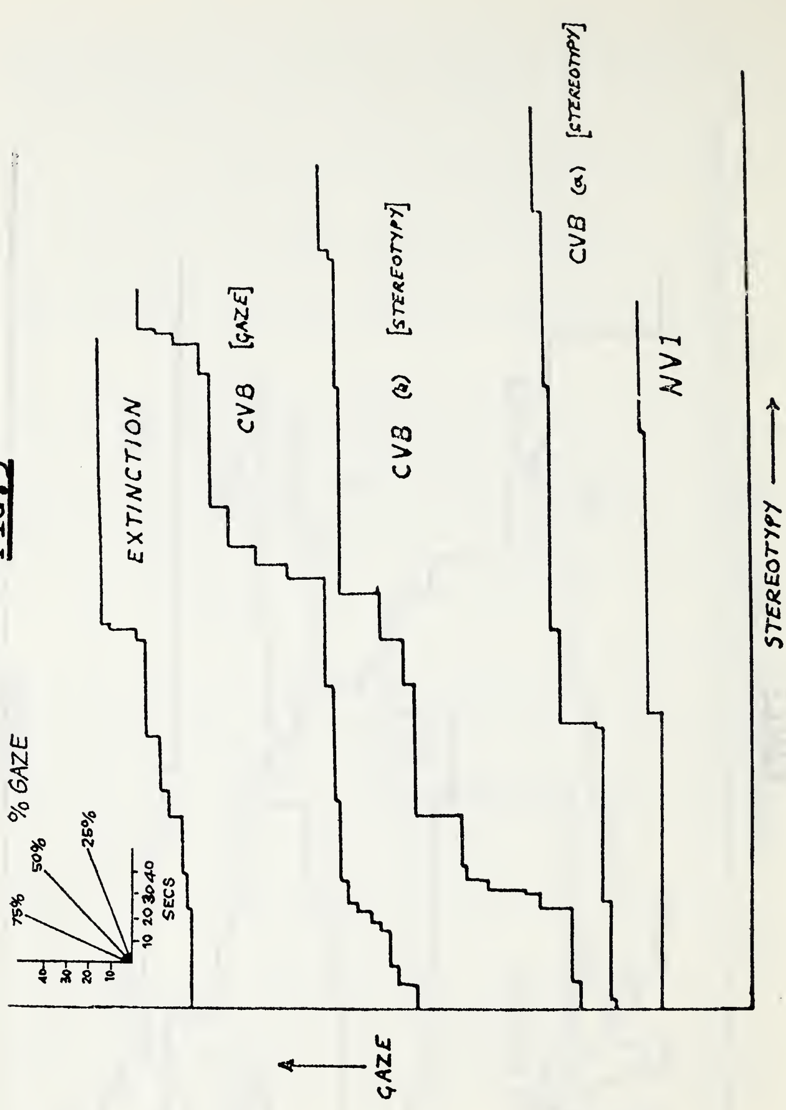
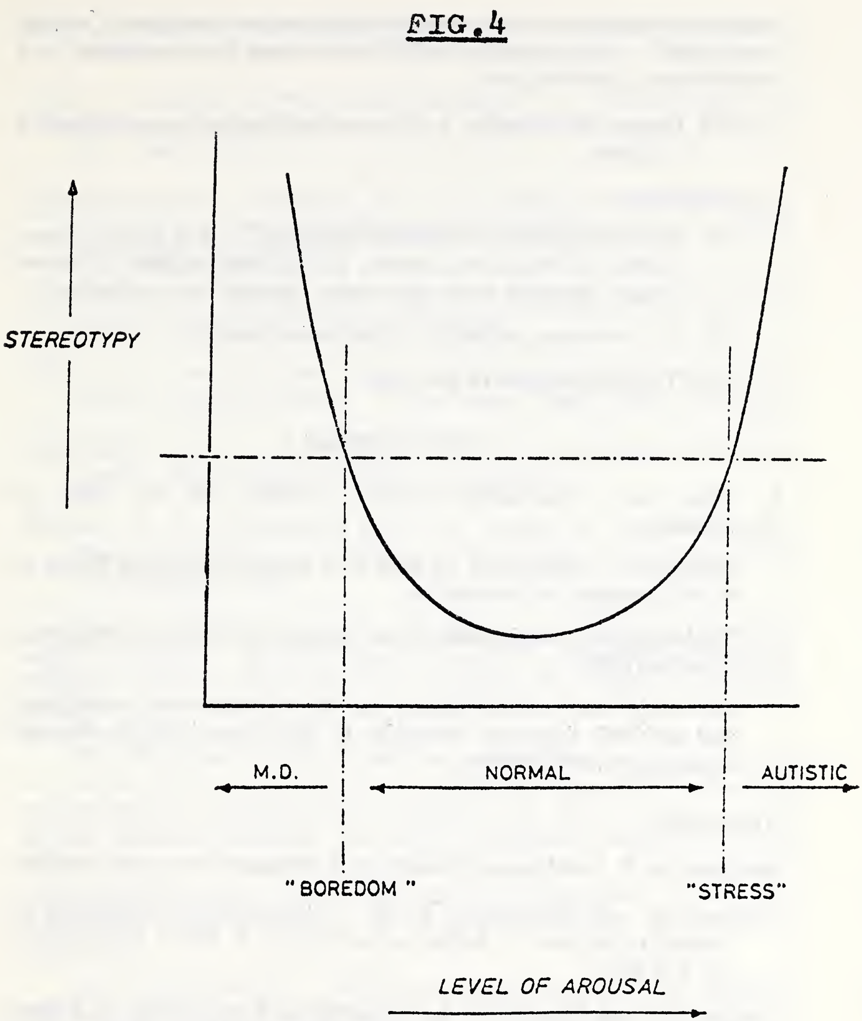

%GAZE
75%
50%
25%
50
40
30
20
10
10
20
30
40
50
NV2
C.V
NV1
GAZE
STEREOTYPY

FIG. 3



The work using the manipulation and recording of levels of arousal can be summarised in a model relating degree of stereotypy to level of arousal across patient groups. Fig. 4 shows how this can be fitted to the standard U-shaped curve. The normal range of arousal is seen as fluctuating within a narrow band of levels related to stress and boredom. As the level of arousal approaches either of the two extremes the per cent. stereotypy increases in a form somewhat akin to a homeostatic mechanism. In the patient groups it is assumed that the defectives and sensory deprived can be seen as being in a

FIG. 4



chronic state of under-arousal, whilst autistics are seen to be in a chronic state of over-arousal.

Overlaid on this arousal model the effect of the environment can be seen to be acting as a modifying agent to determine the topography of the behaviour ultimately generated. The distinction between stereotypy and mutilation possibly arising through a gradual shifting from internal stimuli — e.g. changes in arousal state; to external stimuli — e.g. attention from staff, as the controlling (eliciting) discriminative stimuli.

A continuum from stereotypy being internally cued and maintained on a self-stimulation contingency to mutilation being externally cued and maintained on a social reinforcement contingency can be constructed. Any particular child moves along this continuum at a rate which is a function of—

(1) Degree of disorder and hence ability to learn alternative activities.

(2) Age.

(3) Staff procedures in handling the child, in that more extreme forms of behaviour become the eliciting stimuli for more social attention from staff—thus shaping up mutilation.

(4) The stimulus properties of the environment.

(5) The drug regime of the child.

CONCLUSIONS

1. There is a relationship between arousal and the onset of stereotypy.
2. Stimulus — seeking can be seen as a strong controlling factor in the maintenance of stereotypy.
3. Environmental manipulations can change the relative frequencies of stereotypies.
4. Stereotypy and self-mutilation are on a behavioural continuum and are both therefore, amenable to behavioural change through contingency manipulation.

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Dr. N. O'Connor: May I ask about your findings concerning autistic children? Do you think it would be desirable to measure different kinds of environment in relation to autistic and blind children?

Mr. Williams: With regard to arousal levels in subnormals, one would think that the more handicapped the child is, the less environmental stimulation he is getting and therefore the less is arousal induced externally. In order to maintain arousal at a level which would be considered optimal they would need to provide their own stimulation, and a very good way of doing this is to perform mannerisms such as rocking, or to have it provided artificially by vibration.

Dr. Anne Hayman: I was very interested in what Mr. Williams said because it seemed to me that some of his findings could have a high state of correlation with what we are doing. He has been looking at the external facts and we are concerned with the emotional aspect. What I noticed concerning the stereotype and what he calls the gaze situation, was that it seemed that the gaze situation may be one in which the child had attained comfort and gratification. In fact, in the first photograph we could see that the child was smiling broadly. This could fit in with the points I made, that some sort of gratification is sought in the stereotype and when given in a different way by bodily vibration, the stereotopy is not needed any more. The fact that the child cannot really learn very much seems to confirm this because it seems that whenever he is in a state of hunger, for gratification, or in anxiety, he will need to turn to one or other form of gratification, either the stereotype or the vibration. Another point fits in with something you said. For example, when a child rocks, if you start some music the movement itself can be incorporated into something useful and sophisticated.

Mr. Williams: I agree with all that you have said. All I am trying to do is to demonstrate these causes experimentally.

Mr. S. J. Crews: You referred to a rubella child who may be affected and you also selected on a heart beat basis. The West Indian boy whose photograph was shown seemed very much worse in cerebral damage.

Mr. Williams: The point to be made here is that the heart rate may not necessarily reflect cerebral damage. These two studies were in fact, not done using the same child. The heart rate study was done on an autistic child.

Dr. Robinson: I am sorry, but I have to end the discussion. I call on Dr. Heyes to speak on research into hearing aids for the deaf-blind adult.

HEARING AIDS FOR THE DEAF-BLIND

by Dr. A. D. Heyes, B.Sc., Ph.D., Blind Mobility Research Unit,
University of Nottingham.

This is a brief non-technical summary of some very specialised work that David Gazely and I are doing at Nottingham. The work can usefully be described under three headings: (a) a survey of the deaf/blind population and the hard of hearing/blind population designed specifically to discover their mobility requirements, (b) the development of hearing aids taking into consideration the requirements of the user having the additional handicap of blindness, and (c) the development of tactile displays to enable the transfer of information about the environment to the person who is totally deaf and blind.

(a) *The Survey.*

This has been largely the responsibility of Mr. Gazely, being the psychologist of the team, and has included not only interviews with members of the deaf/blind population but also studies of the mobility performance of certain of the more mobile members of this population. The video films show quite clearly the particular mobility styles adopted and suggest ways in which the standard long cane training programme might be modified, for those clients who are hard of hearing/blind.

The survey has shown quite clearly the general dissatisfaction amongst the hard of hearing/blind with regard to the National Health Service issue hearing aid. Numerous examples have been found of people who have used the aid until they lost their sight but have then given up.

Finally, the survey is showing that there is a significantly large proportion of the deaf/blind population who are well motivated towards mobility. Some indeed are prepared to take enormous risks to achieve their desired independence.

(b) *Hearing Aids.*

Hearing plays a very important role in blind mobility. Not only does the blind traveller attend to sound sources in the environment but he attends also to the echoes of his own self-generated sounds such as foot steps. The blind traveller having normal hearing is able not only to detect the presence of would be dangerous objects but also to achieve a high degree of orientation. It is well known, for instance, that it is easier for a blind traveller to follow a mid-pavement course in a noisy street than it is in a quiet residential road. The traveller is using his ability to hear and localise sounds and to build up a picture of the environment through which he is travelling. Since auditory localisation is dependent to a very large extent on binaural hearing the hard of hearing blind find the monaural Medresco hearing aid of little use in the mobility situation.

An attempt has been made to design binaural hearing aid systems which closely reproduce the sound picture " received " by the normal hearing and using these systems the ability of subjects to localise sound sources has been measured in an anechoic chamber.

Since " natural " hearing involves both inter-aural time and intensity differences it was felt necessary to preserve this information in any hearing aid system. The obvious place for mounting the microphones is at ear level, but in the absence of head movements such systems have not been found to be significantly better than chest mounted microphone systems. We have therefore worked extensively on chest mounted aids for the following reasons; firstly, head movements although useful in accurate sound localisation are thought not to play a large part in mobility orientation and secondly, since the chest mounted Medresco aids are readily available the possibility of using two of these units, perhaps with some simple modification, offers a chance of a solution which could be quickly implemented.

Using chest mounted aids one may (a) use directional microphones mounted centrally — no inter-aural time differences, (b) use ominidirectional microphones mounted at the inter-ear distance — time but no intensity differences, or (c) use directional microphones mounted at the inter-ear distance — time and intensity differences. Oddly enough condition (c) has given results inferior to either conditions (a) or (b) the conclusion being that if one is to mix time and intensity cues then this mixture must be correct for sounds coming from all angles or else " distructive " interference will take place — N.B. time-intensity trading.

The inter-aural intensity differences experienced by the normal hearing human are a complex function of both the angle of the sound source and the frequency of the sound. Since the diameter of the human head is equal to the sound wave length of a 1·2 KHz tone the head offers no shadow to sounds of frequency much lower than this. Conversely high frequency sounds are considerably shadowed giving large inter-ear intensity differences. For tones of approximately 1·2 KHz the shadow is rather complex but is nevertheless known. Thus in order to make the sounds " natural " one must allow the low frequencies to mix in the two channels while keeping the channel separation large for the high frequency sounds. An electrical circuit which achieves this frequency dependant cross-talk has been designed and the components chosen so that the frequency response for the unit follows very closely the frequency dependant shadow characteristics of the human head — the Head Analog Circuit. Interestingly enough the Head Analog Circuit while giving the signals a more " natural " sound for a number of subjects has nevertheless, the result in decreasing sound localisation ability. One may conclude therefore that while, for example, it is " unnatural " to hear a 100 Hz tone coming from one side only it nevertheless increases ones ability to localise the sound source.

The question is raised, therefore, as to whether or not one should aim to reproduce the sounds in a " natural " way. Our early findings are that " naturalness " in this sense adds little to the realism of the sounds and detracts from auditory localisation ability.

A significant step forward has been made by our investigation of the role of learning in the role of auditory localisation. Subjects using a number of our systems have been taught to localise sounds by being given feedback. Not only have results up to the standard of normal hearing been obtained but also strong evidence for the transfer of this learned skill between systems has been found. An important part of the future work will be to discover the extent to which hearing skills transfer to the outside world. Indeed a later stage in this project will be to shift the emphasis of this work from the anechoic chamber to the mobility situation where we shall evaluate the use of the aids using the techniques developed within this Unit by Dr. Armstrong.

(c) *Tactile Displays.*

The totally deaf/blind are not going to benefit from work on hearing aids and it is with these people in mind that investigations are proceeding into the use of the tactile display of information. During the summer of 1971 while on a visit to the Institute of Visual Sciences in San Francisco, Drs. Armstrong and Heyes of this Unit were able to contribute to the final stages of a piece of work the aim of which was to discover the parameters which enable the skin to be stimulated by non-painful electric shocks. Some 16 discriminable intensities of stimulation are possible at an individual site the sensation being both comfortable and localised. Stimulation apparatus has already been constructed at Nottingham and a tactile display for a mobility aid is almost complete. This forms part of the work on displays sponsored by St. Dunstan's.

CLOSING OF THE CONFERENCE

Dr. Robinson: I wish to apologise for restricting discussion and also apologise to all the speakers and the audience at this morning's session for the shortage of time we have had in which to discuss the papers I hope that in future more opportunities for discussion can be given.

Mr. Wall, in summing up, said: First, I should like to emphasise what Dr. Robinson has said about time. In common with the late Dr. Alfred Leonard and Miss Henham-Barrow, I was acutely conscious of the ambitious task we were setting ourselves. Those of you who are statistically minded will be interested to note that we have had 27 papers in 48 hours and also included a certain amount of sleeping, drinking and eating.

I shall not attempt to analyse each of the 27 papers, or even the five sessions, but it would be wrong for anyone here to imagine that because we had 27 papers we have been in any way comprehensive. All of us will know of other research which is going on which, for one reason or another, has not been represented here. So please do not go away and think that you have heard it all, for you have not.

One thing which I am sure this Conference was intended to do and has achieved, was to enable researchers to communicate with each other. I think that a lot of benefit has been derived from informal sessions throughout.

Finally, and I think this the most important thing of all that I want to refer to, there is what I call responsibility in getting the fruits of research to the consumers. Those responsible are, largely, the Royal National Institute for the Blind, St. Dunstan's and advisory and consultative organisations such as the Southern Regional Association for the Blind. Communication, of course, is a two-way affair and if you do not communicate you can blame both ends of the spectrum for not doing it, but I know that the Institute and St. Dunstan's have derived a great deal of information and I hope that the researchers will feel free to communicate with the Institute and St. Dunstan's in future so that we can be assured that there is no unnecessary duplication of effort and that the fruits of research do get to the people who need them, the blind, the deaf-blind and others.

It only remains for me to offer very warm thanks to the chairmen of the five sessions and to those who have given of their time, experience and talents to come here to talk to us all. You will all be pleased to know that the proceedings will be incorporated in one of our Southern Regional reports and sent to all who have been here, and made available to others who want to read them.

Mr. Eric T. Boulter (Deputy Director-General, The Royal National Institute for the Blind): I do not think we should disperse without being given an opportunity, on behalf of all in this room, to express our indebtedness to the Southern Regional Association for the Blind for having this immensely important Conference and giving this opportunity for communication between researchers and those organisations which directly serve the blind. This has been most important. We also wish to express gratitude and thanks to Miss Henham-Barrow and members of her staff for having worked so devotedly, and to Mr. Wall for his excellent chairmanship of this Conference.

This concluded the proceedings.

THE LEONARD CONFERENCE
on
RESEARCH INTO VISUAL HANDICAP

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